EVERYMAN IN HEALTH AND IN SICKNESS

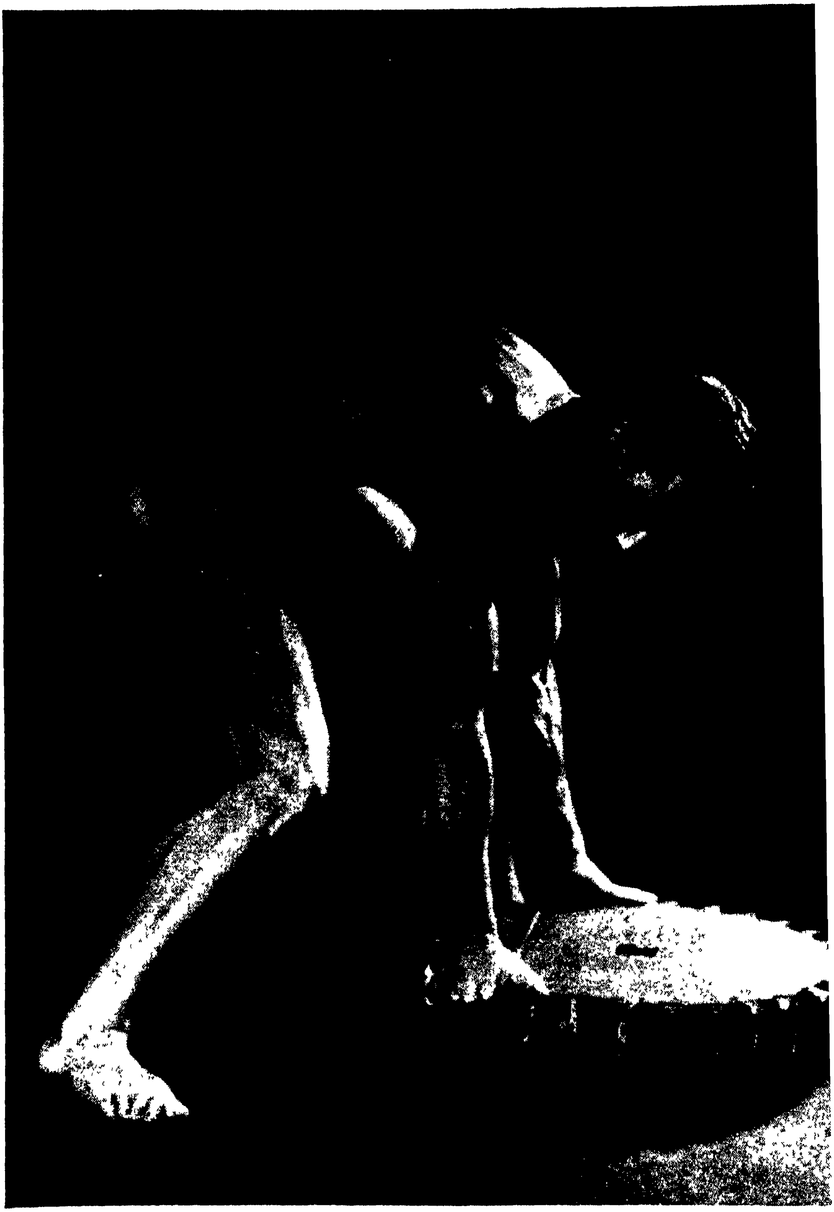

Photo by Herbert Wil

ECONOMY OF EFFORT

All muscles—arms, trunks, and legs—acting together to lift weight

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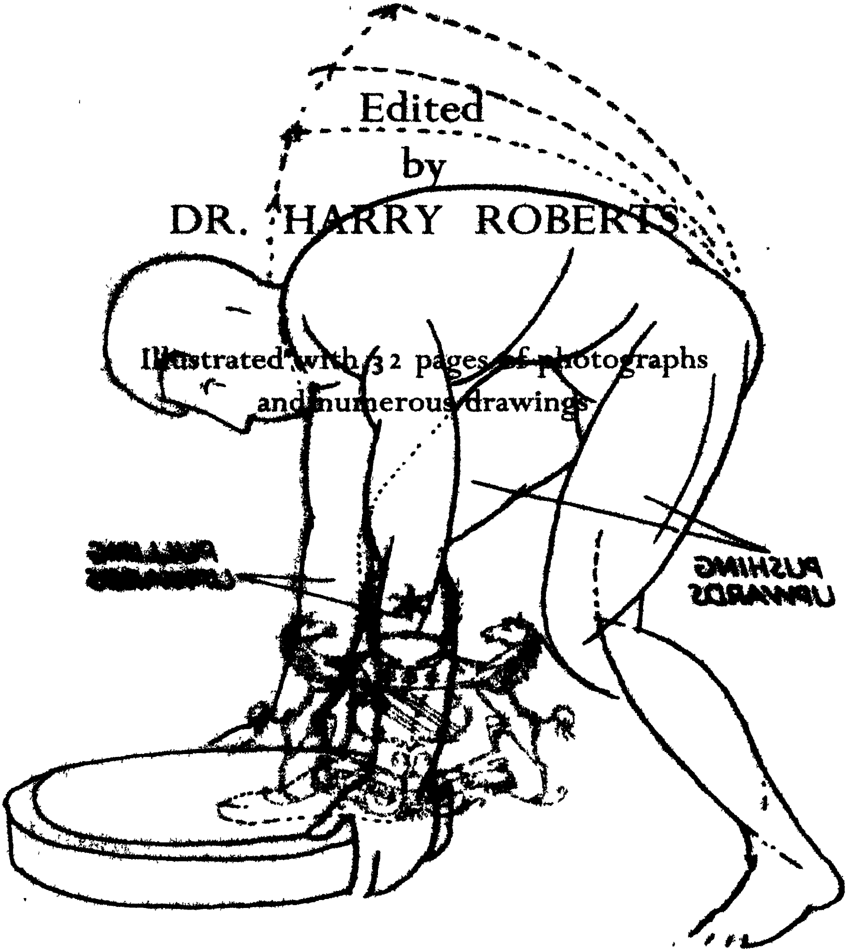

Edited
by
DR. HARRY ROBERTS

Illustrated with 32 pages of photographs
and numerous drawings

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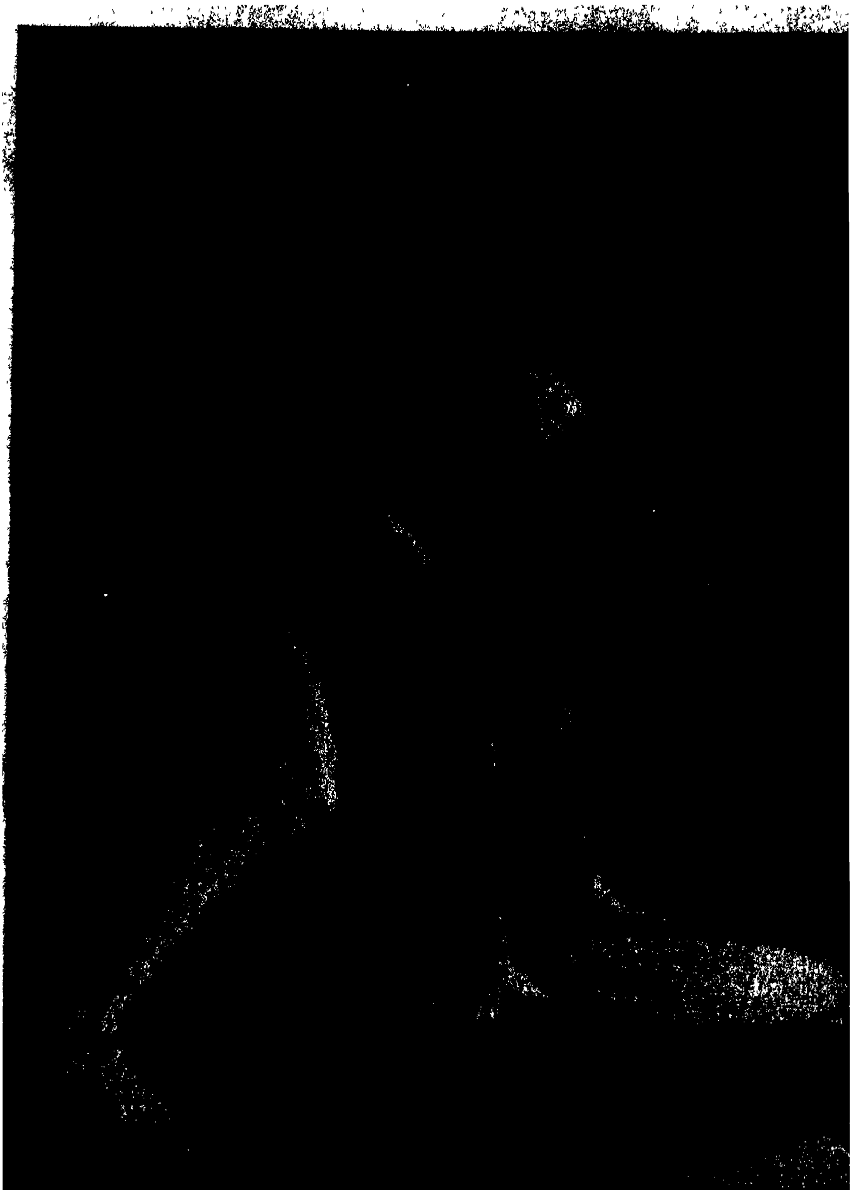

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Introduction

THE problems of health and disease concern every one, and interest nearly every one; yet there are few subjects about which ignorance is more widespread. Nor is this ignorance limited to any one class; the ideas and superstitions of the 'educated' being little less absurd than those of the illiterate. For this intellectual confusion, doctors are in part to blame. They have, through the centuries, been popularly credited with powers and with knowledge far beyond those which they could justly claim. The practice of medicine, consequently, has tended to become a mystery, based on secret doctrines known only to the initiate. That, however, is not the attitude of the leaders of the medical profession of to-day; and for the persistent misconception of the lay-public they cannot be held responsible. Doctors now realize, more clearly than do other people, that in the pursuit of health and in the fight against disease the individual man and woman must consciously and intelligently participate, if success is to be attained. Without widespread knowledge, true hygiene cannot flourish. We cannot safely rely on our instincts for guidance; for our primitive reactions are no longer apt to an environment which we have changed out of all recognition. Every one agrees that the owner and driver of a motor car should understand something of its mechanism, of the care needed to maintain it in a state of efficiency, and of the signs which suggest the expediency of taking it to a garage for expert attention. Surely the possession of similar knowledge by the owner of that much more complicated and personally valuable engine, the human body and mind, is equally desirable. It has recently been said that the average length of human life could be increased by not less than fifteen years, if more people knew what is already known by some, and if the knowledge that has been established were but applied. Ignorance, moreover, does not always take a passive form, or, at any rate, does not always lead to passivity. In the absence of knowledge, man readily becomes enslaved by didactic clichés—often traditional truths which time has turned into fallacies. The result is that popular hygienic notions are still for the most part as fantastic as they were in the days of witch-burning.

In this book, a number of doctors with knowledge and experience of the matters with which they severally deal have collaborated to explain to Everyman and Everywoman the more important of the established

facts of human physiology and psychology, and the bearing of these facts on the problems of health and sickness. The writers are not so foolish as to suppose that they can enable an uninstructed layman to 'doctor' himself and his family with the competence of a technician who has devoted years to specialist study. The aim is rather to assist the reader to understand the machinery of his body, to acquaint him with the observed laws of its harmonious working; and to help him to preserve that harmony within himself, and between himself and his surroundings, which is the very essence of health, and to enable him to recognize those slight aberrations from the normal which, when neglected, have sinister possibilities. In a word, this volume does not set out to create that crazy Utopia in which *Everyman* is *his own Doctor*. Rather it seeks to make the occasions for the doctor's intervention less frequent; and, by promoting the intelligent co-operation of the patient, to render these interventions more effective.

Why does the doctor feel the pulse? Why does he take our blood-pressure with a sphygmomanometer? What are the facts that he hopes to discover when he applies his stethoscope to our chest? How many of us could give intelligent answers to these questions? Yet, both ourselves and the physician would be helped if we could do so; for then we should better understand the nature of the problems that confront him—problems which our understanding co-operation might make far easier of solution.

All the matters dealt with in this book are treated with frankness; there is no place in the realms of physiology and hygiene for conventional reticence. The problems of sex, of marriage, of pregnancy, and of childbirth are discussed helpfully and practically. So, also, are the events peculiarly incident to the several periods of life—infancy, childhood, adolescence, middle-age, and senescence. In these pages are embodied the latest findings of biological science; yet the writers have tried to avoid the use of that jargon in which scientific knowledge is, all too often, expressed. The teaching is neither servilely orthodox nor faddily heterodox. It is believed that no other book yet published covers the same ground, or approaches the subject in the same modern and scientific, yet simple and direct way.

Popular books on physiology have generally tried to simplify the subject-matter so as to bring it within the comprehension of the previously uninstructed reader. This attempt has, however, usually led to the building-up of a picture of living man so incomplete as to be fundamentally false. The truth is that the more we have learnt about the human body and mind and their interrelations, the more complex and the more subtle these phenomena have been found to be. Those who know most about the matter at the present time are they who are most aware of the magnitude of the knowledge we do not yet possess.

There is a danger in presenting facts in too simple a way; and, doubtless, some readers new to the subject will find one or two of the sections in this book none too easy to follow at the first reading. In some instances, it may be wise for the beginner to skip these sections for the time being, and to return to them later, re-reading them in the light of the knowledge gathered from the rest of the book. Those who approach the subject for the first time will find in the earlier part of the book a sufficient account of the general working and structure of the human body to enable them to follow with intelligence the hygienic advice embodied in later chapters.

As has been explained, many recognized authorities have co-operated in the production of this volume. On matters of fact, they are agreed. On matters of opinion they may occasionally hold divergent views. It has been thought best that each writer should be left free to express his own views, based on his own experience, rather than to tone everything down to a colourless uniformity. In fact, surprisingly little difference of opinion seems to exist among those most competent to form one.

So large a proportion of current physiological and medical knowledge is relatively new that, inevitably, many of the terms employed to convey this new knowledge will be unfamiliar to some readers. Newly discovered entities and newly discovered relations between things and events naturally cannot be adequately expressed by means of words with old associations. Some terms used in this book will therefore present occasional difficulty; but the meaning will generally be clear if the context is carefully read.

H. R.

1935.

Contents

PART TWO

EVERYMAN IN HEALTH

I—SOME CHARACTERISTICS OF LIFE

LIFE is something quite unlike anything else that we know. It is, therefore, impossible to define it in terms simpler than its own. All we can do is to summarize some of the outstanding phenomena, experiences, and impressions which, so far as we ourselves are embodiments of life, strike us as distinguishing living creatures from non-living objects. Living things, apparently without external force being applied to them, move in space slowly or quickly, and alter their shape seemingly with purpose. In variable degree they all adapt themselves to circumstances in such ways as appear to favour their prospects of survival; moreover, they all have the strange faculty of reproducing their kind, so that, when disintegration overtakes them, similar individuals may occupy their place. Then, again, it is noticeable that all living matter is rhythmic in its activities, events recurring at approximately fixed and even intervals. Thus, our hearts normally beat some seventy-two times a minute, and we inhale air into our lungs about every four seconds; the menstrual periods of women and the limits of healthy human life afford further examples of this periodic occurrence in time. So far as we can see and understand them, the vital activities of all animals and plants are similarly rhythmic, yet, at the same time, adaptive.

It may be, of course, that the whole universe is infused with life, the manifestations of which our senses can but in part appreciate. Ultimately we are driven to introspection—that is, to looking within ourselves for anything real of which we can be sure; and it is with these internal or first-hand experiences that we are by our nature compelled to compare or contrast the impressions which all external happenings make on our minds through the intermediation of our senses. It were the merest vanity to suppose that our minds are capable of forming a true or just estimate of the universal scheme. There is good reason for suspecting that the dog and the bee—to take but two animals at random—are aware of events of which we have no knowledge or means of knowledge. He who was born blind lives in a different world from that which the rest of us enjoy or suffer. After all, our senses are few in number and limited in appreciative capacity. We hear, we smell, we see, we taste, we touch, we appreciate the force of gravity and of resistance. In the light of modern physical knowledge, what does this amount to? Certain particles stimulate

our olfactory nerve-endings. Air-waves vibrating within a certain range of frequency stimulate our auditory nerves. Activities in that suppositious and possibly non-existent abstraction named aether, within well-defined limits, so act on the retina of our eye as to produce in our minds what we call visual impressions. But, outside these limits, are realities some of which have, by the aid of scientific instruments, been recently brought within the boundaries of our sensory recognition. The ultra-violet rays of light and the X-rays are outstanding examples. Of ultimate explanations and of ultimate realities we have at present no knowledge; and it is doubtful if these things are within the potentialities of our knowledge. When we contemplate the lives of other animals and plants, all that we can see is that they exist; that they have forces within them impelling them to react to circumstances in such ways as will favour their continued existence; that they enjoy favours from Nature and suffer blows from her; that they reproduce their kind; and that, with the passage of time, their energy, their sensitiveness, and their adaptability diminish, so that ultimately they become indistinguishable from what we call the non-living matter of the world. We need not therefrom infer that life has no further meaning, or even that the phenomenon we call time has any ultimate significance; indeed, it seems likely that man's reasoning mind is adapted for little more than what we may call biological purposes—that is to say, the maintenance of earthly existence and the continuance of our species. Beyond all that we know, and probably beyond all that we can know, lies mystery. The wisest man is he who has the keenest apprehension of this mystery.

The moral would seem to be that our highest duty, as it is our highest privilege, is to develop to the utmost those faculties of mind and body with which we are endowed. In our estimation of what is highest we have but an indefinable intuition to guide us. Human life, therefore, is bound to involve frequent compromise, and frequent shrugging of the shoulders and making the best of it according to the available light.

II—A GENERAL ACCOUNT OF MAN

MAN has often been compared to a machine; but he is very much more than that. He is machine and driver and repairer and employer, all in one. For convenience of study we often separate these various aspects; and, again and again in the course of this book, the reader will come across such terms as mind, emotions, body, consciousness, and unconscious processes; but he must not allow himself to think that these are really separate and distinct things, capable of acting or of functioning independently of one another. Man is a unity, itself a harmonious blend of living unities—a harmony of greater complexity than anything devised by man himself.

MAN'S INTERNAL ENVIRONMENT

But for the discovery of the microscope we should scarcely have realized how elaborate and how subtly organized is the texture of that structure which we call man's body. The doctrine of evolution, implying as it does our relationship with the whole animal kingdom, has enabled us to unravel many mysteries by studying them in their simpler forms. We have learnt that all living creatures have much in common, however various have been the developments from the common root. One of the most revolutionary discoveries ever made by science is that man and every other animal and every plant in the world is composed corporeally of minute living entities called cells, each one of which is far too small to be seen by the naked eye; and that every individual man, animal, and plant in the world begins his or its life as a single one of these cells, which in suitable conditions divides and multiplies and differentiates according to established, and apparently predetermined, rules, until a maturity is reached, each according to kind. We have examples of every degree of elaboration, from the lowly amoeba, which lives its entire life as a single microscopic cell, and propagates its kind by dividing into two separate creatures, each an almost exact replica of its parent, to that highly developed and specialized community of cells which is Everyman. About the emotional and mental life of other animals, we can do little more than make plausible assumptions—likely guesses; but their bodily structure and their reactions to various stimuli we can observe with the help of our senses. These observations have thrown a good deal of light on the fundamental

nature of man, and on the meaning and purpose of his several parts. This does not mean that the mystery of life has been solved, or that we are appreciably nearer to its solution; for, as we resolve one item of mystery, five others, hydra-like, present themselves. Science, indeed, when properly considered, makes for increasing awe and wonder, that is for increasing reverence.

It is a curious reflection that about himself, about his own bodily and mental mechanism, the ordinary man knows far less than he knows about his motor car. The queerest notions obtain about human anatomy, human physiology, and human psychology, even among the highly cultivated. Every kind of superstition about health and disease can find a suitable soil for its implantation in all strata of society. Almost all the knowledge that has been acquired has hitherto been confined to a small specialized section of esoterics who have formed a caste apart. The practice of medicine is inevitably a matter for trained experts; but it is obviously absurd, as it is undesirable, that Everyman, entrusted, as he is, with the driving on the high roads of the universe of the most elaborate and the most dangerous vehicle conceivable, should be in complete ignorance of the structure of the machine, of the means necessary to put and keep it in good working order, of where the brakes are situated, and of the signs that indicate the urgent need of a visit to the garage.

If we are to understand even the bodily structure of man we must go back to its beginnings. The little unicellular organism, the amoeba, lives in water. It seems likely that the primal organism, of corresponding simplicity, from which man has evolved was also a water animal, presumably living in the sea of its period. It is an interesting and relevant fact that every one of the millions of living cells of which man's body is composed to-day is also a water animal, needing for its continued existence to be constantly bathed in a saline fluid, the composition of which resembles in many ways the probable composition of the primitive sea.

In another section of this book the relation between man and his external environment are discussed in some detail. But the living units of which man's body is composed do not for the most part come into contact with these external conditions; they have an environment of their own which, in contrast to that outside us, is markedly uniform. One of the most mysterious and wonderful things in human physiology is the elaborate and highly co-ordinated mechanism, if mechanism it can be called, whereby this internal environment is kept constant. The individual cells of our body live in a fluid medium which, for present purposes, we may regard as the blood itself. From this they derive their sustenance and their air; into this they discharge the waste products of their activity. Although we, regarded as entities, are

capable of a striking degree of adjustment to varying circumstance, our individual cells are by no means so responsive or so resilient. A very slight variation in the temperature, or in the chemical composition of the fluid in which they are bathed, spells for them death. Winter and summer, in the Tropics and in the Arctic regions, the temperature of human blood varies but by a small percentage. How heat is produced and how regulated is explained elsewhere; so, also, are the processes whereby the salinity and the chemical constitution of the blood generally are kept uniform, or approximately uniform. It would seem to the fancy that there are within us well equipped chemical laboratories and highly efficient chemists, prompt in analysis and apt in adjustment, having slight relation to our consciousness, and beyond the rule of our intelligence and will.

We need to realize these facts if we are to have any rational comprehension of the nature of sickness and disease. Many of those unpleasant experiences which we call the symptoms of illness are due quite as much to the efforts of our defensive forces as to the direct irritation of our outside enemies. Some invasion by germs, or breach of tissue-continuity by alien substance, disturbs the delicate balance of our bodily colony. That in itself may well be discommoding to our consciousness. But, straightaway, the unseen healing power within us, what the ancients called the *vis medicatrix naturae*, gets to work to destroy, or to envelop, the disturbing agent; and to restore the balance thereby upset. These counter-efforts often give rise to pain and discomfort, and sometimes even to danger as great as the discomfort and danger brought about by the original disturbance itself. It will be seen how careful needs to be the physician who would play a part in this battle; for, unless he realizes the nature of the campaign, and correctly interprets the manifestations of the efforts of the attackers and the defenders, he may easily, with the best intentions, hinder, rather than help, that happy outcome of the battle at which he aims. Modern doctors, to the surprise of their often protesting patients, not infrequently endeavour, instead of mollifying certain unpleasing symptoms of illness, actually to exacerbate them, because physiological science has taught them that only thus can they hope to assist the patient's directing forces which are endeavouring to restore harmony to the complicated organism for whose unity they are responsible.

THE MIND: CONSCIOUS AND UNCONSCIOUS

All the activities which we call vital seem to be motivated by some queer immeasurable force which we call mind. Mind, like life, is a very difficult thing to define. The word is commonly taken to imply

one or other of those higher developments which distinguish man from most of the other animals; but there is good reason for supposing that the elements of mind are to be found in even the lowest unicellular organisms. Indeed, if we accept the evolutionary theory we must perforce conclude that the mind of man and the minds of all the higher animals are but developments of the rudimentary psyche that infuses the being of the humble amoeba.

Even consciousness itself may in some tenuous form be present in every living animal cell. Modern psychological and physiological research has thrown increasing light on the wonderful adaptive regulation of our internal functions, so elaborate and purposive as to be inexplicable along what we call mechanical lines. It is not we as conscious individuals, but some purposive forces within us, that cause the heart to beat regularly and rhythmically some seventy-two times a minute; that directs an increased flow of blood to those parts of the body temporarily in need of it; that maintains our body at a nearly uniform temperature winter and summer, when our machinery is actively running as when it is almost stationary; that preserves an almost constant composition of the blood, no matter what we may eat or what we may drink. Moreover the psychologists tell us, and their arguments seem convincing, that most of our acts in response to external stimuli, and even our thoughts and tastes, are settled, not by our conscious will, but by an unknown fount of power within us to which the name 'the unconscious' has been provisionally given.

The Nervous System

In a unicellular organism, such as the amoeba, in which there is, apparently, no appreciable degree of specialization of function, there would seem to be no need for a system of intercommunication; but, so soon as the multicellular stage of evolution has been arrived at, certain cells being told off for special purposes, on the fulfilment of which the well-being of the whole depends, something of the nature of a postal, telegraphic, or telephonic service is obviously needed. In man, the most important instrument of intercommunication is the central nervous system; the headquarters of which are located in the brain and spinal cord. In these structures are grouped together an enormous number of very highly specialized cells, called nerve-cells, from which proceed not only short extensions establishing rapport with neighbouring nerve-cells, but also long fibres, after the manner of telegraph-wires, through which messages may pass from the directive centre to the motor mechanisms of the body. Similar nerves connect the receptive sensory organs with headquarters. All this is more fully described later in this book.

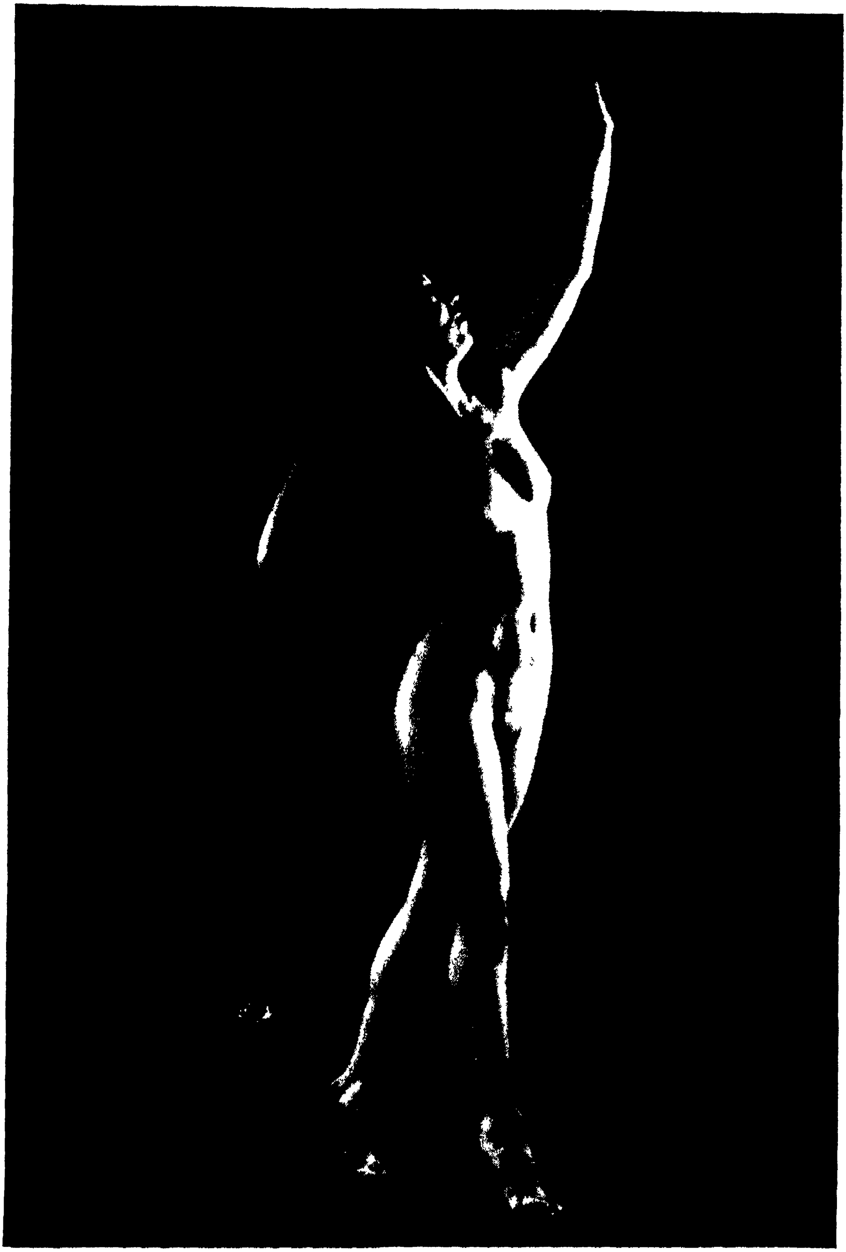


Photo by Herbert Williams

BALANCE

The arms used as movable weights

Our emotions are older than our reflections on them, and it is an interesting fact that we have in our bodies, side by side with that system of telegraph wires or nerves the administrative centres of which are in the brain and spinal cord, a far more ancient nervous system, corresponding with that to be found in certain lowly animals apparently possessing no brain or nervous system responsive to anything that can be called a conscious will.

This so-called vegetative or involuntary organization of nerves, though unresponsive to our will and intellect, is highly susceptible to climatic and other environmental conditions, as well as to emotional states. A few instances may be quoted. When the surrounding air is cold, the blood-vessels of our skin contract, thus exposing a smaller volume of blood to the cooling air; whereas, when the surrounding air is relatively warm, or when we are engaged in active physical work or exercise, these surface vessels dilate, thus helping to maintain the uniformity of the blood-temperature. This important adaptation is none of our willing, the regulation being effected by the force behind the vegetative nervous system, in collaboration with the so-called endocrine glands, described elsewhere in this book. Here is another example. In the face of imminent danger or of aggression, we commonly experience the emotion of fear or of anger. The physical phenomena which accompany these emotions are significant. We commonly speak of a man as being pale with fear, or pale with anger. What has happened is this: endocrine glands called the adrenal bodies, which are intimately related to the vegetative nervous system, instantly produce an increased—though still minute—amount of a very potent drug called adrenalin. This drug passes into the blood, and causes in an amazingly short time a contraction of the blood vessels of the skin and of the digestive organs, at the same time dilating the blood-vessels that feed the muscles of the limbs and the muscles of the heart. We experience a feeling of muscular tension and of energy; work which is temporarily unnecessary, such as digestion, is held up, the task of the moment being to flee or to fight. At the same time, supplies of energy-making fuel are liberated into the blood from our great store-house, the liver. All arrangements are made promptly and in order as for a campaign. Here again, our conscious will takes little or no part in the work of organization; yet it would be using the word 'mind' in a very narrow sense if we excluded it from participation in these organized and obviously purposive proceedings.

The Circulation of the Blood

An organized community obviously needs not only a system of intercommunication, but also a transport system for the conveyance of actual materials to and fro. It is impossible to form a coherent idea of the organization and workings of our body unless we have in our mind a clear picture of this transport system.

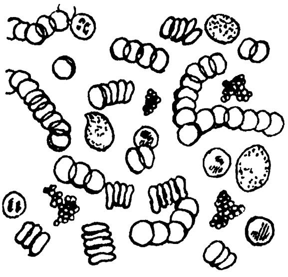
That which, within our body, takes the place of the canals, roads, and railways of our country, is the blood-circulatory system. This is described in some detail elsewhere in this book. Here, it may suffice to say that through every part of the body runs an elaborate arrangement of tubes through which blood is constantly being pressed forward; the main pressure is exercised by the recurrent contractions of a sort of muscular ball, the heart, from which proceed large tubes or vessels through some of which, called arteries, blood is, some seventy-two times a minute, squeezed onwards, whilst, through the others, the large veins, blood is poured back into the heart, ready, in turn, to be pumped out into the arteries. All of these large vessels branch and ramify, the ultimate branchlets being so small as to be invisible to the naked eye.

The heart is divided into four compartments, two on its left side, and two on its right. On each side there is a receiving-chamber and a pumping-chamber. Between the receiving-chamber and the pumping-chamber on each side there is a communicating door, opening one way only; but between the two sides there is no direct communication. The big artery from the left pumping-chamber conveys blood to its branches which are distributed throughout the body. This blood is returned through veins to the right receiving-chamber; thence it passes to the right-hand pumping-room, the arteries from which take the blood to the lungs to be aerated. From the lungs this oxygenated blood passes to the left receiving-room of the heart, whence it empties into the left pumping-chamber, and so, once again, is distributed to all parts of the body. Into the blood passes, as it circulates through the walls of the intestines, the prepared and utilizable nutriment with which our body-cells have constantly to be furnished.

The blood-stream, however, not only brings to the cells the oxygen and nutriment they need, but it also, like a scavenger, carries away the waste products of the cell's life and activities to specialized organs which prepare them for elimination from the body. The blood, indeed—or the lymph which exudes from it—constitutes, as has been explained, the actual environment of all our body cells; only the outer surface of our skin and the inner lining of our respiratory and alimentary tubes being in direct contact with external nature.

THE COMPOSITION OF THE BLOOD.

The blood, however, is not just a moving fluid, like the water in a canal or a navigable river; but is to be looked upon rather as a liquid tissue of the body. It is a thickish, viscid fluid, containing a number of interesting and important ingredients. It makes up about a fifteenth of our body-weight; the average volume of blood in a man amounting to about six pints. More than one-third of the weight of the blood is contributed by millions of little solid disks called corpuscles; the size of which may be gauged by the fact that in a cubic millimetre of human blood (a millimetre is about one twenty-fifth of an inch) there are normally nearly five millions of corpuscles. These circular corpuscles are reddish in colour, the colour being due to a most important constituent, a substance called haemoglobin. The chief function of the red corpuscles is to convey oxygen from the air-cells of the lungs to the millions of cells that make up the body; and in this work the haemoglobin plays a leading part. The red corpuscles, unlike ordinary animal cells, contain no nucleus and are incapable of reproducing their kind. They soon get worn out, when they are scrapped by certain organs specially detailed for the work. The red corpuscles are not the only solid objects in the blood. Little less important, though fewer in number, are various kinds of pale cells, collectively spoken of as white corpuscles. The two chief classes of these are known as leucocytes and lymphocytes. These are larger than the red corpuscles, and have no such clearly defined form. They have many important functions to perform; one of the most notable being to engulf or otherwise destroy dangerous bacteria and other potentially poisonous particles. The fluid medium in which these corpuscles live is called the blood-plasma, in which are dissolved the various salts and nourishing elements required by the body for its sustenance and for the liberation of energy. Blood removed from the body quickly coagulates into a solid mass or clot. After a little while this clot separates into two parts, a solid network in which the corpuscles are enmeshed, and a relatively clear fluid called serum. The physiology of the blood, and of the circulation generally, is more fully described in Part I, Section VI.



NORMAL BLOOD CORPUSCLES

LYMPH.

Essentially, if not quite literally, however, the blood circulates round the body in closed tubes—the arteries, veins, capillaries, and heart. Yet the individual cells of which our bodies are composed remain the

water animals their primordial ancestors always were. They do not come into direct contact with our blood, though it is the blood that carries to them the nutriment and oxygen that they need, and takes away from them the waste which is the invariable accompaniment of vital activities. How is this transference effected? Nature has provided an intermediary agent in the form of a fluid called lymph. All the cells of our body are surrounded by and embedded in a loose or open-woven living fabric which anatomists call connective tissue. In the interspaces of this tissue is lymph; and this is the true sea in which our infinitesimal component parts live, much as their ancestors did as unicellular organisms in the primitive sea. This lymph is much like blood without its red corpuscles; though there are other differences, which we need not dwell on here. The capillaries are minute, being about one four-thousandth of an inch in diameter, with walls so tenuous that gases, water, and watery solutions readily pass through them. The lymph is essentially an exudation of plasma, or blood-juice, through these capillary walls. The cells of the body, in fact, exist in a kind of bog or swamp through which the capillary tubes run, oozing fluid as they go, and possibly re-absorbing a certain amount in exchange. The lymph which forms the fluid part of these swamps is not quite stagnant, though its movements are sluggish. Leading from these intercellular spaces is a system of lymph-tubes or enclosed canals, which slowly drains them. These small vessels join together, as do the venules or little veins, to form larger ones, all ultimately uniting into a relatively large tube called the thoracic duct, which empties its contents into one of the big veins just before the vein reaches the heart.

The course of these lymphatic vessels, however, is not unbroken; for, here and there in their course, are situated nodes or lymphatic glands which act as filtering agents. All sorts of particles, living and non-living, are held back by the lymphatic glands and, so far as may be, are by them rendered harmless. Most of us know from experience that, when we have a poisoned wound of the finger, lumps are apt to appear in the region of the elbow and in the armpit; and that, when we have a septic sore on the foot or leg, painful lumps appear in the groin. These lumps are inflamed lymphatic glands. The swelling of the glands is due to their attempt to deal with a bacterial invasion that taxes their neutralizing powers almost beyond their capacity. Their function is to prevent, if possible, the entry of dangerous germs or their toxic products into the general circulation. The lymphatic glands are, as it were, protective garrisons, well furnished with leucocytes or white corpuscles peculiarly adapted to destroy bacteria. These garrisons are placed at strategic points, and are especially numerous and closely grouped in parts of the body exceptionally exposed to bacterial invasion. Thus, at the entrance to the throat, through which all

the air we breathe and all the food we eat must enter, Nature has provided a mass of lymphoid tissue, which is often called upon to perform tasks beyond its powers. Inflamed tonsils and adenoids are familiar instances of such undue taxation. It is interesting to find that this protective lymphoid tissue placed along the course of the air-passages is arranged just beneath the surface, so as to be better able to deal with inimical particles, organic and inorganic, which are inhaled with the air we breathe, and to prevent them from getting into contact with more vital parts, and poisoning the general blood-stream.

The tissue-fluid, or lymph—for we may here consider these as practically identical—is thus a bodily substance of profound importance to the maintenance of health and vitality. It is, indeed, our true internal environment, of which the blood and the whole blood-circulatory system may be regarded as the servant. It is from the tissue-fluid that each cell in our body obtains the various materials needed for its own repair and growth, as well as the fuel and the oxygen requisite for the production of energy liberated in the course of its individual activities and of its contributions to the collective activity of the whole organism of which it forms a part. From the tissue-fluids also, cells receive those chemical messages which are embodied in the so-called hormones, manufactured in specialized organs responsive to emotional states, themselves set going by external events. Into the tissue-fluid is emptied all the cell's refuse—the dust and ashes of its domestic life. From the blood capillaries, this lymph derives its utilizable materials, and into the blood-stream it again pours those waste products which it is expedient to get out of the way before they have had time to do injury. In the lymph are, as has been said, numerous mobile white cells similar to the white corpuscles of the blood. These are active scavengers, engaged in constant warfare with microscopic parasites, such as the bacteria, and ever ready to engulf and render harmless foreign particles of all kinds. Quickly these cells assemble at seats of danger, as every one who has suffered a septic wound, however trifling, must have experienced. They make up the bulk of the defensive army in those congested battles which are associated with the process which we call inflammation. Every chink and cranny of the body contains lymph; and the more fully the physiologists are able to unravel the subtleties of its composition, the greater will be the power and the success of the arts of hygiene and of medicine.

The Excretory System

When we burn wood or coal in our grate there is always a residue of ashes composed of incombustible material. Also, our fireplaces must be provided with chimneys to permit the escape of various gases

and vapours liberated from the fuel when it is burnt. Essentially the same problems arise, and similar results ensue, when the fuel manufactured from the food we eat is burnt in the various tissues of the body; the incombustible parts—the ashes, as it were—are, it is true, separated from our food before this is distributed to our thousands of little fireplaces, so that what actually reaches these is all burnable. The ashes remain in the intestines, and are then excreted. But although the fuel that reaches our tissues is all burnable, yielding heat and energy in the process of combustion or chemical combination, the by-products of that combustion still remain to be got rid of. They are, as it were, the smoke and the steam and the true gases that domestically escaped through the chimney. These have to be removed from the working parts, for all of them are obstructive to smooth working, whilst some act as poisons, or quickly change to poisons, if they are allowed to stagnate.

It has been explained that the blood is the great carrying medium of fuel and air to all parts of the body. Arterial blood is charged with both fuel and oxygen; but, having discharged its load, the blood does not return empty. In the tissues it again loads up with the surplus water, the carbonic acid gas, and other combustion products, and clears them out of the way. The carbonic acid gas, as has been explained, is ultimately taken to the lungs whence it is breathed out into the air. Some of the by-products are worked up again in special organs, as components of utilizable substances. The rest are distributed to certain glands and organs which, as it were, pick them out of the blood and remove them from the body altogether. A good deal of the water is eliminated by the sweat glands of the skin; but the most interesting and remarkable of our eliminating organs are the kidneys. It is by means of the kidneys that most of our tissue waste and of our nitrogenous waste products are sorted out and got rid of. The cells of the kidneys have this strange property of selecting from the blood which circulates round them, not only this nitrogenous waste, but any excess of water and of various salts over and above the proportions in which they normally exist in human blood. The substances thus removed constitute the urine, which is collected in a cavity known as the pelvis of the kidney. From the kidney on each side proceeds a tube called the ureter, whereby the urine is drained into the bladder where it accumulates until a sufficient degree of tension is experienced to give rise to the conscious urge to pass the urine from the body. The canal leading from the bladder through which this discharge takes place is called the urethra. The work of the kidneys is discussed in greater detail in Part II, Section V.

III—OUR SENSES AND SENSE ORGANS

We none of us know very much about ourselves; but we are inclined to think that we know a great deal more about the world outside us than in fact it is possible for us to know. Our knowledge of things outside ourselves is confined within the limits of our sensory receptiveness. We can see some things, but there are far more things to which our eyes are insensitive. By means of scientific instruments we have learnt about the ultra-violet rays of light, and the infra-red rays; but these are invisible to us. Our retina is not adapted to receive light messages unless the wave length and the frequency of vibration of the rays fall within certain clearly defined limits. So with our ears and our nostrils, so also with our organs of taste and of touch. The ingenuity of scientists has discovered means of transforming many world-happenings so as to bring them within our range of appreciation. The microscope, the mechanisms of telephony, telegraphy, and the wireless, and the apparatus of the radiologist are well-known examples. But only in so far as these artifices bring phenomena within the normal boundaries of our inherent sensitiveness do they widen our acquaintance with the material universe. It would seem that man's equipment of mind and of body is primarily schemed to enable him to maintain his identity —that is to exist as a separate and defined individual—for a limited period of time. We have reason for suspecting that there is an element of divinity, that is of capacity for wisdom, in every one of us; but our nature is mainly an animal nature, and our knowledge of material things differs but in degree from that of our furred and feathered relatives. It is well that we should recognize not only our powers and opportunities, but also the inescapable limitations of our natural equipment.

There are certain features common to the mechanisms of all our senses. There is, associated with each, a receptive apparatus, an almost mechanical conveying instrument, and a mysterious organ situated in the brain which transforms these stimuli in such a way as to be interpretable by our mind. Usually the receptive apparatus is understandable enough. There are mechanisms devised by man not dissimilar and equally sensitive. Nor is there anything beyond our comprehension in the conveying instrument, the nerve which passes the impersonal impulse from the sensitive receiver to the appropriate cells of the brain. It is at the inner terminal that mystery lies. We can offer no satisfactory explanation of the strange phenomenon of psychic interpretation. Certain 'ethereal' vibrations are by what we call

mechanical methods directed to the retina of the eye; and impulses in themselves meaningless are transmitted through the fibres of the optic nerve to specialized cells of the brain. Then by some mystic interaction of mind and matter, we seem to 'see' men and women or trees or clouds or sheets of water. These visions we take to be realities, but we have no means of checking our inference. So with hearing, so with touch. Until the message reaches the terminal interpreter, there is nothing in this machinery fundamentally different from man-made instruments we constantly use; but we have made nothing, nor do we know of anything, remotely corresponding with those strange happenings in the brain and in the mind, the total of which makes up our conception of the world we live in.

Although the nerves proceeding from our sensory receptive organs have been given special names, there is no fundamental difference between them. They are not to be regarded as specialized or selective. If we are in a very dark room, and receive a blow on the eye, so as to send a message along the optic nerve, it is a flash of light that we seem to see. In an atmosphere that to others seems one of silence, stimulation of the auditory nerve imposed deliberately or by some local disease gives rise to the sensation of sound—a 'buzzing in the ears' or a 'ringing in the head.' Any message received by a particular brain-cell is interpreted as arising from an impression of that kind to which alone the receptive organ at the further end of the nerve leading to it is normally responsive.

Thus is explained the well-known experience of sensation referred to a foot long since amputated—the stump of the nerve which originally conveyed the foot's messages being in some way stimulated or irritated.

The Eye

Of all our specialized receptive sensory organs, perhaps the most elaborate, as it is in many ways the most important, is the eye. The whole of our surface is to some extent responsive to light; though probably far less so than is the surface of many animals less locally specialized. This diffused sensitivity, however, provokes little or no attempt at intellectual interpretation. Physiological and even emotional activities may be thus affected, but nothing that comes within the realm of 'knowledge' or of conscious thought is created by any impressions except those made on specialized sensory organs, and therefrom transmitted to specialized parts of the brain. Everything in man is wonderful, but few of his organs, according to his own estimate, are perfect. It has been said that any skilful optician to-day could make a better lens than the one possessed by the most clear-visioned of us.

The eye is a roughly spherical organ, able to be moved from side to side and up and down in its socket, beyond which its anterior part protrudes. It has a sort of rind, or wall, and contents. The most highly specialized part of the eye is a layer of tissue spread over the inner surface of the hinder part of the wall. This is called the retina, and its main feature consists of a very large number of nerve-endings of a peculiar kind, sensitive only to light-rays of varying wave-frequency. The stimuli thus afforded by light pass along fibres which together make up the large nerve called the optic nerve, in direct connection with a part of the brain solely concerned with the transformation of these messages. Most of the light-rays that impinge on the retina are reflected from material objects, and the complications involved in our mental interpretation of these reflected rays, whereby we form images or pictures of things—trees, houses, people, and so on—are such as to defy not only description, but also clear understanding. The area of the retina is obviously a very small one; and if only those rays of light which spontaneously fell on it were, as we say, visible, the field of our observation at any given moment would be a matter of inches. The picture would, in fact, be of pretty much the same size as the retina itself. We know how large a landscape can be made to reproduce itself in image on a very small photographic plate. But for the arrangement of lenses and other apparatus that makes the camera this would, of course, be impossible. A one-inch plate would take but a one-inch landscape. What we may call the mechanical part of the eye is very much like the camera. It was long ago discovered that rays of light passing through a piece of glass with a convex surface are bent inwards, that is, towards the centre of the glass's convexity. This process is called refraction, and is the basis of the optician's technique when he fits us with appropriate spectacles. Our eyes are furnished with a convex lens, differing but in material from the glass lenses of the optician. This, however, is not quite true; for the so-called crystalline lens of the eye is elastic, and by means of muscles attached to it can, within certain limits, be made more or less convex at will. This capacity for modifying the convexity according to need is of the highest value to us; since, obviously, rays of light coming from a great distance (as when we are looking at remote objects), if they are to impinge on the retina, must be refracted or bent at a very different angle from that necessary in the case of rays reflected from near-by objects. Accordingly, we automatically vary the convexity of our crystalline lens according to whether we are looking at something quite close to us, such as a book, or a piece of newspaper, or at a distant ship or mountain-top. Some people have lenses insufficiently convex to see clearly objects near them. Others have lenses the convexity of which cannot be sufficiently reduced to enable distant rays of light to be properly

refracted on to the retina. These are the sort of defects which the optician, with reasonable success, remedies.

In front of the lens is a small sac, or chamber, which is filled with a fluid called the aqueous humour, whilst between the lens and the retina lies another chamber, the semi-fluid contents of which are spoken of as the vitreous humour. The outer layer of the wall of the eyeball proper is a tough membrane spoken of as the sclerotic; and it is to a part of this membrane that we refer when we speak of the white of the eye. In front a circular area of the sclerotic is transparent to light; and this transparent part is called the cornea, 'the horny window' of the eye. Lining the greater part of the sclerotic membrane is a dark layer of tissue known as the choroid. It is on this, at the back of the eye, that the retina is based. Between the cornea and the crystalline lens is the chamber containing the aqueous fluid; but at the back of this is an important membrane called the iris, with a central aperture, the pupil, the size of this aperture being regulated automatically according to the amount of light to which the eye is exposed, and also according to the distance of the object to which attention is directed. The iris is thus a sort of curtain with a central diaphragm corresponding to the diaphragm of the camera. The iris is coloured by particles of pigment, and it is this which determines what we call the colour of the eye—grey, hazel, or brown. In the very young infant, this pigment has not properly developed, and, accordingly, a young baby cannot safely be exposed to very brilliant light. Those races of man which occupy the less sunny parts of the world are usually blue-eyed, whereas those in more tropical areas generally have more deeply pigmented irises. Over the front of the eyeball is a thin membrane, called the conjunctiva, which, being reflected on itself, is continuous with the inner lining of the eyelid. It is this membrane which is usually first irritated by foreign particles, such as dust or minute pieces of steel or grit. The inflammation which is thus set up is known as conjunctivitis. At the outer corner of the eye-socket is a gland called the lachrymal gland, which manufactures the salt fluid we call tears. Normally, a little of this secretion passes slowly and continuously over the surface of the conjunctiva, cleansing it as it goes; and, at the inner corner of the eye, runs down a minute tube called the lachrymal duct, which leads to the inside of the nostril. The presence of irritating foreign particles on the surface provokes the lachrymal gland to increased activity, and the flow of tears across the eye may be greater than can be coped with by the lachrymal duct. We then say that the eye waters. Very similar is the effect of certain emotional states.

The Ear

Next to the sense of sight that of hearing provides man with his most satisfying means of contact with the outside world. As with the visions which we seem to see, so with the sounds that we seem to hear, we have no means of knowing the extent to which these impressions correspond with external happenings. The sights and sounds that we see and hear are in us; they are subjective interpretations of certain impacts on our bodies; but, for all we know, they are as much fancies as are the hallucinations of the mentally deranged. All that we know about the impulses that give rise in us to the sensation of sound is that they fall on our ears in the form of air-vibrations of varying frequency. Above and below certain limits of frequency these vibrations are not recognized by our sense of hearing; and the capacity of individuals in this matter varies a good deal.

For convenience of description the auditory apparatus has been divided into four parts. Innermost, and in every way the most subtle, is the auditory centre in the brain, a special group of brain cells, the fibres of which extend out as parts of the auditory nerve to sound receptors in what is called the inner ear. This latter consists of a small tube coiled after the manner of a snail (whence its name, the cochlea), lodged in a recess of the skull and filled with fluid. The outer boundary of this little canal is closed by a delicate membrane, separating it from the next compartment, the so-called middle ear. This chamber is filled, not with liquid, but with air. On its outer side is a tougher membrane, the tympanic membrane or drum of the ear. The tympanum can be seen with the aid of a flash-light at the extreme inner end of the outer ear-tube or meatus. Stretching across the middle ear from the drum to the delicate inner membrane is a lightly-hinged series of three minute bones, which act as levers. The aerial vibrations which fall on the tympanum are transmitted by these ossicles to the inner ear, where they cause movement in the contained fluid, to which movements the auditory nerve terminals are sensitive. Serious damage to any part of this transmitting mechanism is likely to bring about deafness, entire or partial. The air-pressure in the middle ear is automatically maintained, so that between the inside and the outside of this compartment the pressures may be kept equal. This balancing is effected through the instrumentality of a narrow passage, the Eustachian tube, which connects the cavity of the middle ear with the throat, where the opening of the tube can be seen in the neighbourhood of the tonsil at either side. When the tonsil or the pharynx is inflamed and swollen, the entrance to the Eustachian tube is apt to become obstructed, either by pressure or by becoming blocked with mucus. Air may thus be

prevented from entering the ear-chamber, the internal pressure of which accordingly falls, and the conveyance of sound from outside is disturbed or obstructed. There are, unfortunately, worse possibilities; for the inflammation in the throat—or rather, the septic infection of which the inflammation is a symptom—may spread to the Eustachian tube, and actually invade the middle ear itself. An abscess may form there, and the delicate joints of the little bony levers may be permanently deranged. The trouble, if not promptly dealt with, may spread even further.

The outer tube or auditory meatus is in direct contact with the surrounding air. This tube enables the drum of the ear to be hidden below the surface, and so less exposed to direct injury. Even so, however, it can be burst by severe blows on the side of the head, or even by a very loud noise, such as that of a near-by explosion. Such wounds of the drum, however, usually heal with comparatively little permanent damage to hearing; but this is not the case when, as a consequence of suppuration in the middle ear, the drum becomes perforated from within owing to the pressure of pus. The external shell-shaped appendage which most people mean when then speak of the 'ear' is the least important part of man's auditory apparatus. To some small extent it may help to collect aerial vibrations, but it is doubtful if our acuity of hearing would be appreciably reduced were we deprived of these sound-collectors. In many other animals they are certainly of the highest importance, especially when—as is usually the case—they are able to be moved freely in all directions.

The meatus protects the drum also from less violent but no less dangerous contacts. It is lined with fine hairs, and is furnished with numerous small glands which secrete wax. This wax forms a coating on the surface-lining of the passage, and helps, as do the hairs, to hinder the entrance not only of dust and small foreign particles, but also of flying and creeping insects. Normally, the small amount of wax produced gradually dries, and with the matter it has entrapped, works out of the ear. But sometimes, in some individuals, it accumulates within the meatus so as, ultimately, to prevent aerial vibration from reaching the drum. Partial or complete deafness results, which can, however, easily be put right if the ear be syringed with tepid water, skilfully injected by means of an aural syringe.

Continuous with the cavity of the inner ear are three semicircular canals, arranged at right angles to one another, two in a vertical, and one in a horizontal plane. These canals, which have membranous walls, encased in bone, contain fluid, and it is by impressions provoked by the shifting of this fluid that we are able to appreciate our position in space. Our sense of balance or equilibrium is mainly dependent on the healthy working of this mechanism. To disorders of the inner

ear, and consequently of the semicircular canals, fits of giddiness can often be attributed.

The Tongue and the Nose

The receptive organs of taste and smell may be considered together; for much that we commonly speak of as taste is really smell. The receptive organs of taste, the taste-buds, as they are called, are situated in the surface layers of the tongue, chiefly at its sides. They consist of minute funnel-shaped depressions, projecting into which are numerous fine nerve-endings. These nerve-endings respond but to four qualities: sweetness, sourness, bitterness, and saltness. In order to stimulate them, the substance must be in solution, either in water or in saliva. Consequently, insoluble substances have no taste. The sweet, bitter, sour, or salt solution, in order to be recognized as such, enters these little depressions, and comes into contact with the nerve-endings. The stimulus thus given is duly interpreted by the mind operating through the special gustatory cells of the brain.

Most of the sensations that we commonly speak of as taste or flavour are, as has already been said, really agreeable or disagreeable smells. People who have bad colds in the head often complain that they can taste nothing; though, as a matter of fact, they may be as discriminating as other people between the four tastes that mark the diagnostic limits of every one. Their trouble really is that they cannot smell, owing to their olfactory receptors being blocked by mucus or by the swelling of adjacent tissues. These receptors are situated in the higher part of the nostrils where they are exposed not only to air breathed in through the nose, but also to air from the back of the mouth; with which the nasal passages are connected. It is presumed that the olfactory nerve-endings are stimulated, as are the gustatory ones, by material contacts involving chemical interaction. So small, however, must often be the particles given off by the odorous body, which yet are recognizable by our sense of smell, that many people have thought it more probable that the mode of excitation of the olfactory nerve-endings has something of the character of the vibrations of light rather than of that of material entities. It is said that a gram of musk will give off its strong odour for years without weighing appreciably less at the end of the time; and that the smell of one ten-thousandth of a gram of the substance known as mercaptan (the smell-principle of the skunk) is perceptible even when it is diluted with fifty million times its own volume of air.

An epicure, wishing to get full aesthetic value out of a glass of wine or a cup of choice tea, breathes in through his mouth, after taking a sip of the liquid on his palate, and then breathes out through his nostrils. In this way he is able to get the full flavour or fragrance.

The Touch

The receptive organs on which impressions must fall in order to give rise to the sensations of sight, sound, smell, and taste, occupy a very small part of the body's surface which comes in direct contact with our external environment. But, distributed over almost the entire area of the skin are more than a million nerve-endings, sensitive to heat and cold, to touch and pressure, or to those more positive assaults which give rise to pain. The nerves which convey the messages which we interpret as heat or cold are, however, distinct from those which convey the messages of touch and of pressure. It is said that there are about a quarter of a million spots on the surface of the body receptive to the sensation of cold, and about one-eighth of that number receptive to heat. The spots responsive to the contacts which we interpret as touch or pressure are much more numerous. These latter in particular are readily localized by the mind, so that, with our eyes closed, we instantly know to a nicety what part of our surface is being touched or pressed on. The slight difficulty in discrimination that is sometimes experienced if two spots close together are simultaneously touched, depends on the relative closeness of the sensitive nerve-endings in that particular area.

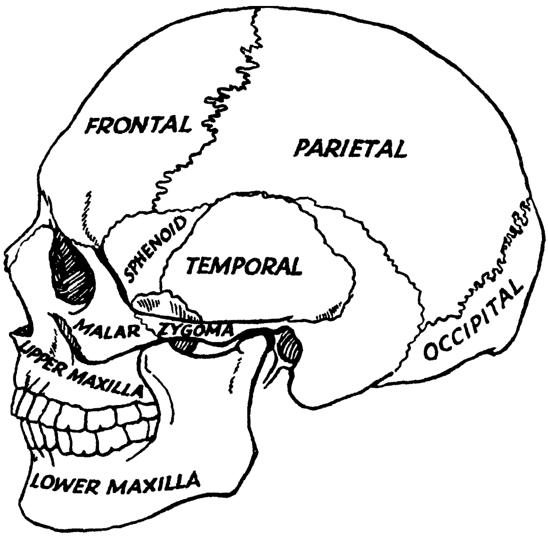
Internal Sensations

All the senses hitherto described are concerned with impulses from outside us. But we are capable, also, of experiencing sensations from within our bodies. Normally, when all is going well and smoothly, we are scarcely conscious of the reassuring messages sent to our central nervous structures from our various organs and tissues. Habitude leads to unawareness—and this is true even of many of the external impacts on our senses. The fragrance of a rose held too long to the nostrils is no longer recognized; familiarity breeds a sort of anaesthesia. When, however, there is variation in the stimuli on a nerve-ending, attention is arrested as by a sudden noise; and our consciousness wakes up. All the internal pains and discomforts we from time to time experience are indicative of such disturbances of the routine harmony that in perfect health prevails.

IV—THE GENERAL STRUCTURE OF THE BODY

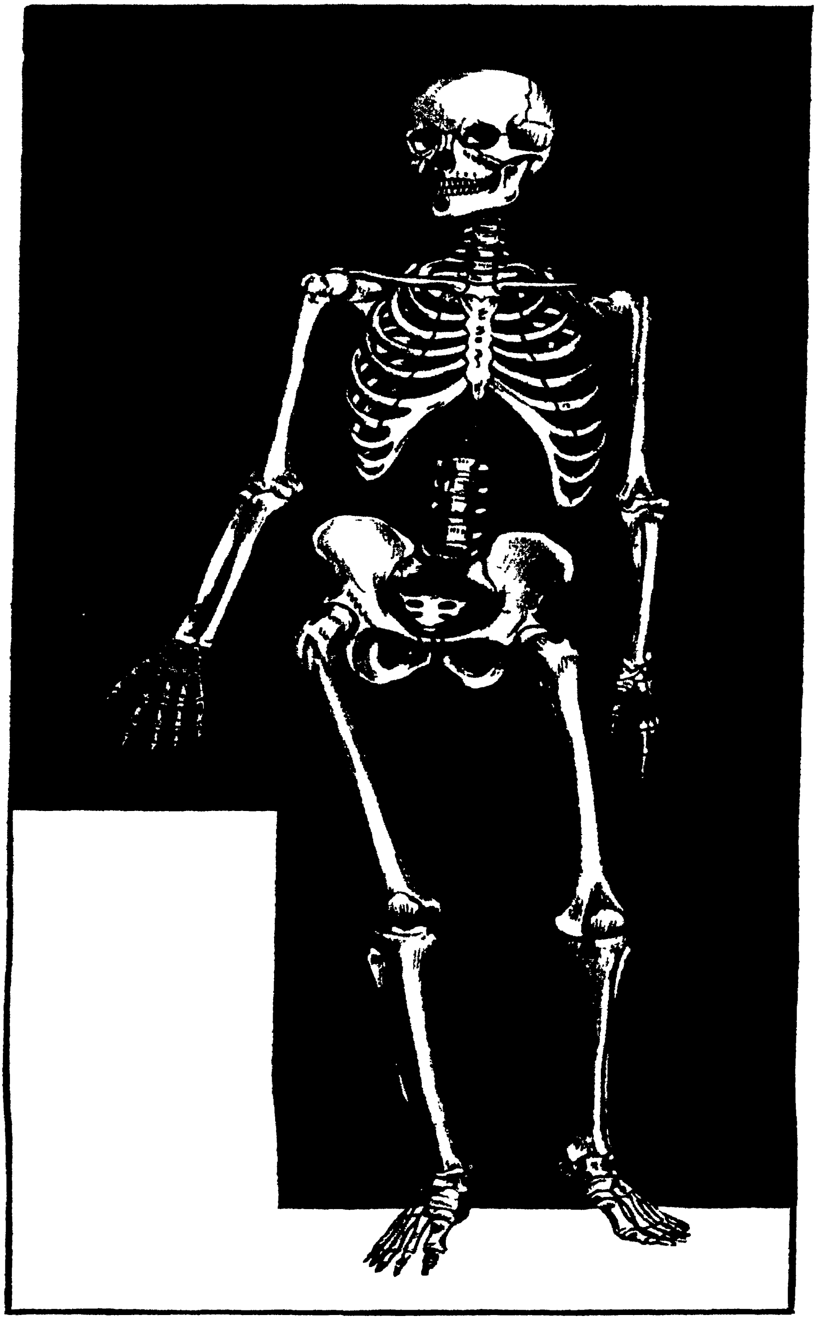
The Skeleton

The core or framework of the body is formed by the bony skeleton; and it is the arrangement of the bones that gives the body its general shape. Our progression in relation to the surface of the earth is effected by altering the relative position of these bones, which are jointed or hinged together so as to enable them to be separately moved. As we stand upright we have at the top the hollow arrangement of bones which together make up the skull. With the exception of the lower jaw these bones are in the adult so firmly jointed together that they are practically incapable of separate movement. The jointing, however, gives additional strength, and this is necessary, for within the skull is the important organizing and administrative bodily organ, the brain.



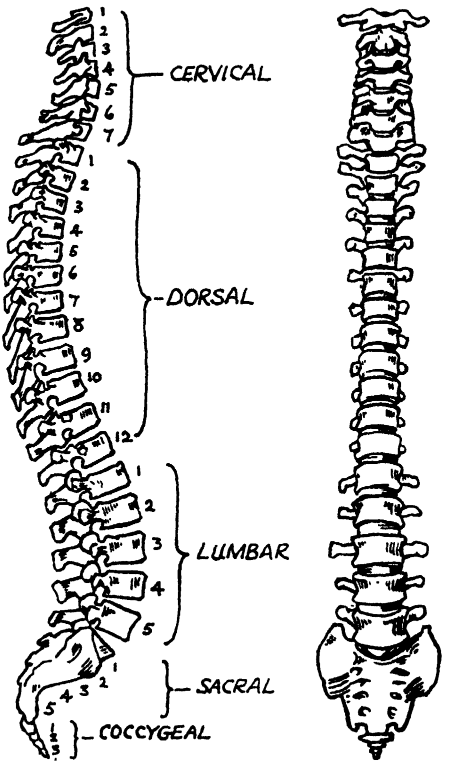
BONES OF THE SKULL
Side view

The skull rests on top of a pile of thirty-three bones, known as the vertebral column. Between the skull and the two higher vertebrae provision is made for a good deal of circular movement; but, between the remaining vertebrae little movement, beyond such as will allow a gentle curving of the body, is possible. Arching round from the higher part of the vertebral column are the slender curved ribs, which are jointed in front to a flat bony plate, known as the breastbone or sternum. These ribs, with the sternum in front and the backbone behind, form the cavity known as the thorax, in which the heart and lungs are contained. At the top of the breastbone on each side is a bone shaped like the letter '*f*,' the collar-bone or clavicle. At the posterior upper part of



THE HUMAN SKELETON

the thorax is, on each side, the flat three-cornered bone called the shoulder-blade or scapula. At the upper and outer corner of the scapula is a shallow bony socket, in which the rounded end or head of the long bone of the upper arm, the humerus, loosely fits. The lower part of the vertebral column consists of two groups of united vertebrae, the upper and larger of which is called the sacrum, the lower and smaller constituting the coccyx. In animals that have tails the coccyx constitutes the bony framework of the tail. Firmly jointed with the sacrum on each side are two strong flat curved bones, the hip bones, which unite in front; the whole forming a sort of basin, called the pelvis. This constitutes the base of the trunk, and supports the weight of the abdominal organs when we are standing upright. Each of the two hip bones has a socket, rather like that of the shoulder-blade, but much deeper; in this socket fits the head of the femur, the long bone of the thigh. On account of the depth of this socket dislocation of the hip joint is very much rarer than is dislocation of the shoulder joint.

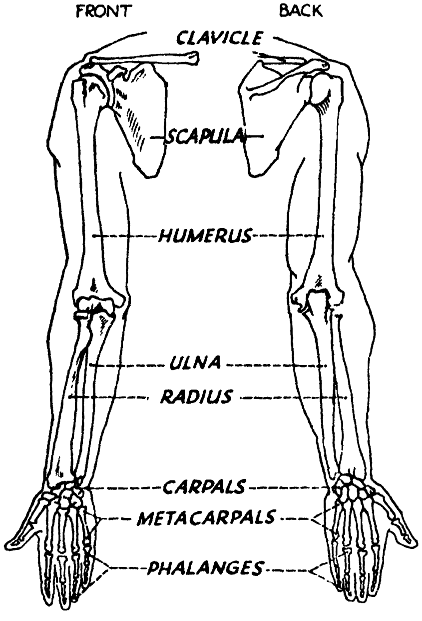


Side view Front view

VERTEBRAL COLUMN

The bones of the arms and legs are arranged on very similar lines. The femur in the thigh and the humerus in the upper arm are respectively jointed below to two bones: the tibia, or shinbone, and a long slim bone, called the fibula in the leg, and the ulna and radius in the forearm. The fibula and the radius are on the outer side of their respective limbs; the radius, however, is so jointed at its upper end as to be capable not only of being folded up in common with the ulna so as to make them nearly parallel with the humerus, but also of rotation, so as to turn the hand over and bring the thumb from the outside to the inside, or vice versa, and thus permit of the hand being placed palm upwards or palm downwards. At the wrist an arrangement of eight bones, jointed on to the radius and ulna above, allow of a considerable

freedom of movement at that joint. Articulated with these carpal, or wrist, bones are five bones known as the metacarpals, which extend to the roots of the fingers and thumbs; each of the fingers being furnished with three bones, called phalanges, and the thumb with two. The ankle and foot are structures on somewhat similar lines, but the ankle, or tarsal, bones are more rigidly attached to one another, and the phalanges of the toes are shorter than are those of the fingers.



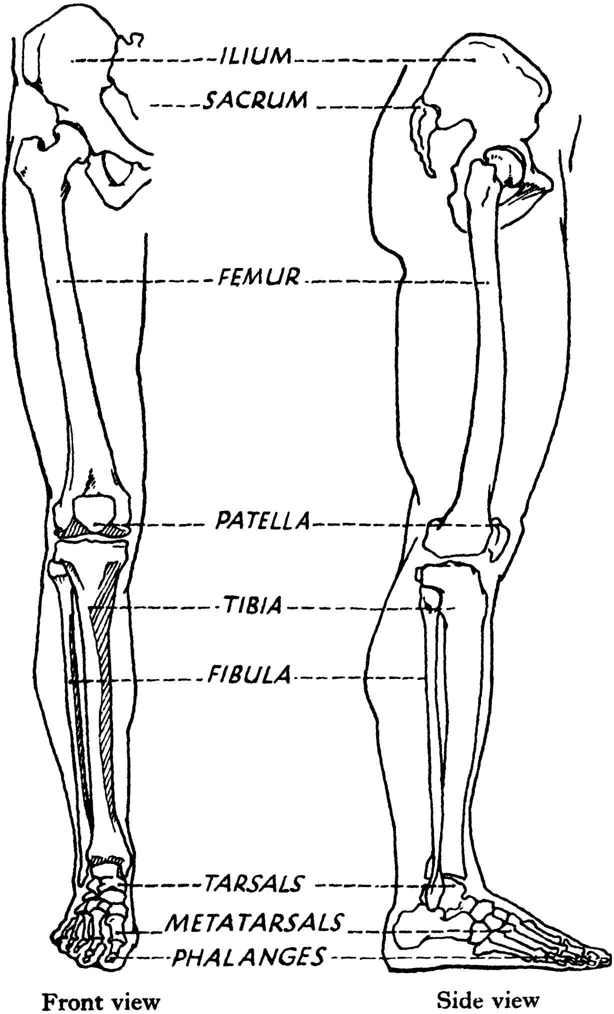
BONES OF THE ARM AND SHOULDER

Where two bones come together to form a joint there is an intermediate layer of elastic cartilage or gristle which serves to diminish vibration and shock. The whole joint is enclosed by a tough membrane, the inner surface of which 'secretes,' or produces, a lubricating material known as synovial fluid. Sometimes, when a joint is injured, the synovial membrane becomes irritated and inflamed, and produces an abnormal amount of fluid. This condition is called synovitis. The bones taking part in a joint are connected and prevented from becoming too widely separated from one another by means of tough cords or ligaments. These ligaments are attached by one end to one of the bones, and by the other end to the other bone. Most joints are also supported by the tendons of muscles, about which more will be said later. Many different kinds of joint are exemplified in the human body. Thus, at the shoulder and hip, we have examples of the ball-and-socket, enabling movements of flexion and extension and of abduction and adduction, as well as of rotation. At the knee, we have a simple hinge-joint, allowing of little more than movements of flexion and extension. More will be said about joints and their mechanism later in this book.

The Muscles

The bones themselves have no power of movement. They are moved in relation to one another by the pull of muscles. The muscles consist essentially of bundles of living fibres which, when stimulated, have the faculty of contracting or shortening. In the case of the muscles

of the limbs one end of each muscle is firmly attached to one bone, and the other end to another bone. When the muscle contracts, its two ends are necessarily brought nearer together, and one of the bones to

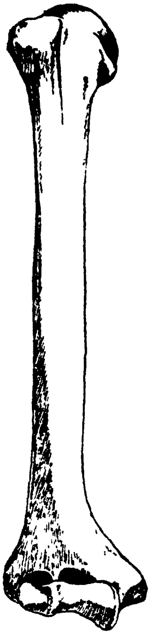


Front view Side view

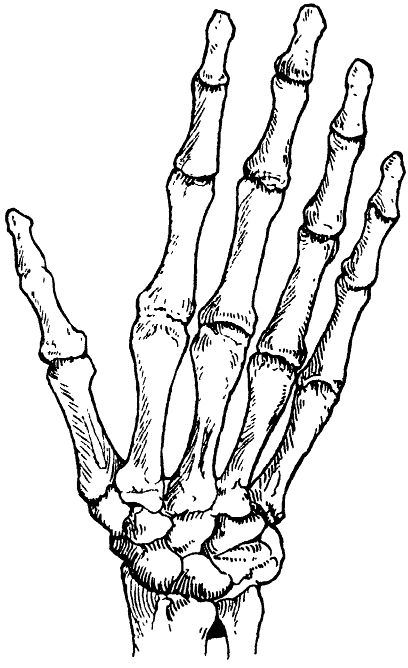
BONES OF THE LEG

which it is attached is compelled to move accordingly. To take a typical muscle, the biceps; this is attached at its upper ends to one of the shoulder bones, at its lower end to one of the bones of the forearm. When we wish to raise our forearm, as when we lift a cup of tea to our lips, a stimulus is sent to the biceps by our mind through a nerve which

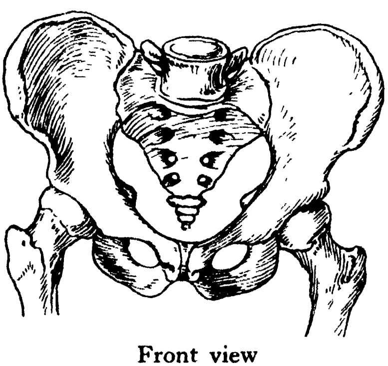
causes the muscle to contract. If, with our other hand, we grasp the upper arm whilst we carry out this manœuvre, we can feel the biceps



HUMERUS

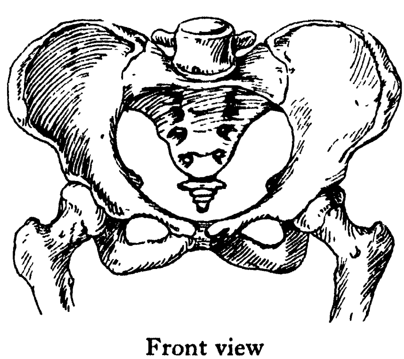


BONES OF THE HAND AND WRIST



Front view

BONES OF THE MALE PELVIS

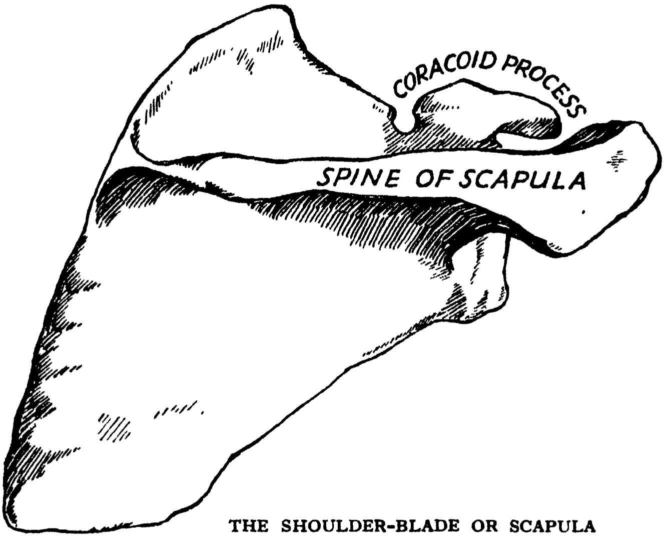


Front view

BONES OF THE FEMALE PELVIS

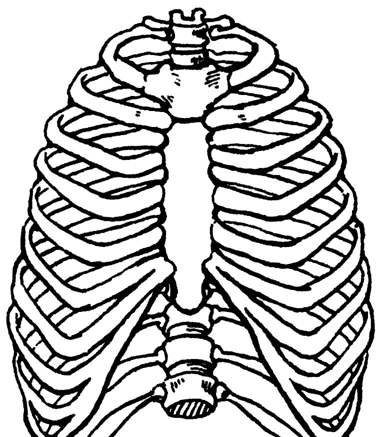
muscle thickening as it shortens. In fact, the movements of our limbs are much more complicated than this might suggest; each movement being graduated and regulated with an eye to economy and effectiveness.

This also is more fully explained in the section of this book devoted to physical exercises. In order that the muscles may do their work



THE SHOULDER-BLADE OR SCAPULA

they must be supplied with material embodiments of energy, just as must an internal-combustion engine or a steam engine. Moreover, the muscles, like all other parts of the body, are composed of living cells, which need a constant supply of nourishment, oxygen and water, to enable them to live at all. All these things are supplied to them by that common carrier of the body, the blood.

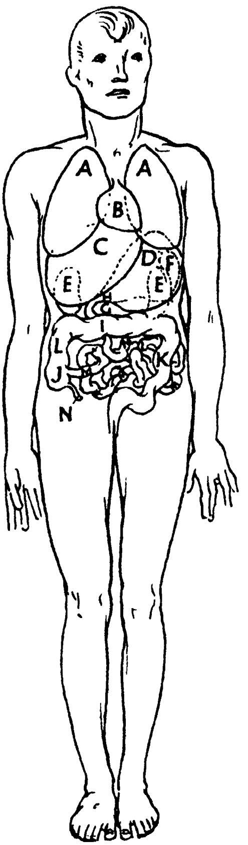


THE BONY THORAX

The Chest

The central of the three main compartments into which man's body is divided is the chest, or thorax. The bony framework of the thorax is shaped after the manner of a truncated cone. At the back are the twelve dorsal vertebrae; at the front, the sternum or breastbone, ending below in a flat piece of cartilage known as the ensiform cartilage. Arching round the chest from the vertebrae to the sternum are the twelve ribs on each side, the lower of

which are called floating ribs, because they are not attached in front directly to the sternum or its cartilage. Between the ribs lie the intercostal muscles, enabling chest movements to be effected. At its upper end the thorax is continuous with the neck; below, it is bounded by a muscular sheet, domed upwards, called the diaphragm or midriff. The thorax contains two of the most important organs in the body, the heart and the lungs; both essential to life.

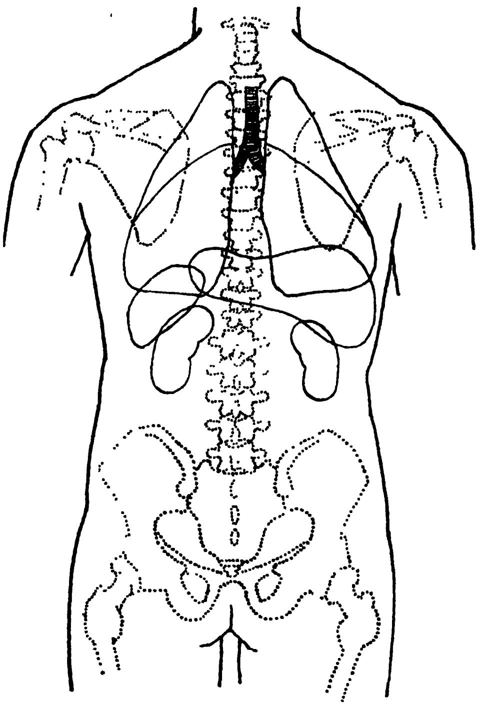


A. Lungs
B. Heart
C. Liver
D. Stomach
E. Kidneys
F. Spleen
G. Pancreas
H. Pylorus
I. Transverse Colon
J. Caecum
K. Descending Colon
L. Ascending Colon
M. Small Intestine
N. Appendix

THE LUNGS.

On entering the chest the windpipe, or trachea, bifurcates into the two bronchi, each of which again divides and subdivides into smaller and smaller tubes known as bronchioles, the smallest subdivisions of all terminating in bunches of minute bladders called air-cells. The walls of these air-cells contain numerous capillary blood-vessels; and it is while the blood is passing through the walls of the air-cells that it gives up its waste gas, carbonic acid gas, and takes in or absorbs a fresh supply of oxygen from the air in the air-cells. The importance of this purifying and re-aerating of the blood is explained in Part I, Section VI. The lungs are simply a mass of these air-cells and of the tubes leading to them, bound together by connective tissue; they thus have a very spongy feel and appearance, since air makes up a good deal of their bulk. They are covered by a membrane, called the pleura, which continues over the inner surface of the chest wall; there are thus two layers of the pleural membrane, which are separable, though, on full inflation of the lungs, in relatively close contact. So that the two layers may move freely over one another, the cells of which the membrane is composed manufacture, or secrete, a lubricating fluid, the pleural fluid. It is this membrane which sometimes becomes

infected by bacteria, as a consequence of which inflammation results, and the person thus affected is said to suffer from pleurisy. The friction between the two layers of membrane often gives rise to considerable pain, in an effort to relieve which, additional fluid is often secreted. This fluid may become infected and purulent. We then have the condition known as empyema, which is but another name for an abscess in the pleural cavity.



BACK VIEW OF BODY
Showing position of organs

The act of respiration is performed by alternately expanding and contracting the walls of the chest. As the walls expand the lungs also expand, and draw air into themselves; when the chest wall contracts air is forced out. It will be seen how harmful is any form of garment that restricts in the slightest degree the free movement of the chest wall. It should, perhaps, be explained, that an enlargement of the chest cavity can be brought about, not only by the raising of the ribs and a consequent increase in the chest's diameter, but also by a lowering of the dome of the diaphragm, consequent on movements of the abdominal muscles. There is usually a noticeable difference between the breathing of men and women in the relative reliance placed on the chest and on the abdominal muscles, though this is much less marked since female fashions in dress became more sensible, and the old, rigid corset ceased to be commonly worn. The difference, in any case, is probably due far more to divergent fashion in dress and physical habits than to fundamental sex distinction.

THE HEART.

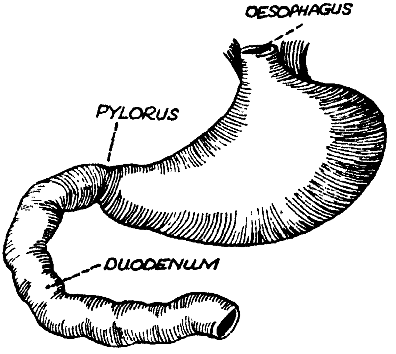
The other important organ of the chest is the heart, which lies obliquely a little to the left of the middle line. Its structure and functions have already been briefly explained; and are discussed more fully in the Chapter devoted to Circulation and Respiration. Here it

may be repeated that the heart-muscle contracts—that is, automatically squeezes itself—seventy-two times a minute, thus forcing the blood out through the arteries, the openings to which are guarded by valves which allow a one-way flow only. Many of the serious forms of heart disease essentially consist in damage to one or other of these valves which, consequently, is no longer effective. The cavity of the heart is lined by a membrane called the endocardium, which is liable to bacterial infection, with very serious consequences, and covered externally by another membrane called the pericardium. This also may become inflamed and give rise to distressing symptoms.

The Abdominal Cavity

The diaphragm forms the upper wall of the abdomen, the contents of which rest below on the basin-like pelvis. Behind, are the lumbar vertebrae, followed by the five vertebrae which are joined together to form the sacrum which is continued below as the coccyx, consisting of four small terminal vertebrae, also joined together. The abdominal cavity is lined by a two-layered membrane called the peritoneum, corresponding with the pleura of the thorax. Just as the inner layer of the pleural membrane is reflected over the surface of the lungs, so is the inner layer of the peritoneum reflected over the intestines and other structures occupying the abdomen. The upper, and larger, part of the abdominal cavity is occupied by structures concerned in the digestion of our food and the adaptation of its constituents to the needs of our tissues. The largest single structure in the abdominal cavity is the liver, which in an average adult weighs from three to four pounds. It occupies the upper part of the cavity, the bulk of it being situated to the right of the middle line. It extends up into the hollow of the dome of the diaphragm, and is almost entirely covered in front by the lower ribs and their connecting muscles. Lying against its under-surface is the gall-bladder, in which the bile secreted by the liver is collected. The functions of the liver and of its secretions are described in the section dealing with the digestive system. Opposite the liver, on the left-hand side of the upper part of the abdominal cavity, is the stomach, which is a muscular pouch shaped somewhat like a bean, and capable of distention, according to the volume of its contents. Its larger end, the fundus, is well to the left, lying under the lower ribs. Into this end the gullet, or oesophagus, which passes at the back through the thorax and diaphragm, enters. The smaller end of the stomach is situated near the middle line of the abdomen. This is known as the pyloric end; and it tapers off into the beginning of the small intestine. There is a valve situated at the pyloric orifice which regulates the entry of the

stomach-contents into the bowel. The normal healthy stomach of an adult, after a meal, has a capacity of a little under two quarts. Further dilation is generally indicative of morbid changes. The small intestine is about an inch in diameter, and about twenty-seven feet in length; it lies in coils, and occupies a considerable space in the abdomen. On the right side of the lower part of the cavity the small intestine joins the large intestine, the length of which is usually between five and six feet. Near where the small intestine and the large intestine join, is the small, blind pouch known as the appendix, which is connected with the dilated intestinal cul-de-sac called the caecum. The first part of the large intestine ascends vertically from the caecum, then proceeds across the abdomen to the left side, and descends. These parts are known as the ascending, transverse, and descending colon. At the bottom of its descent the colon again curves slightly upward; and then, like an inverted 'U,' finally descends to the rectum, which terminates in the external opening, the anus.



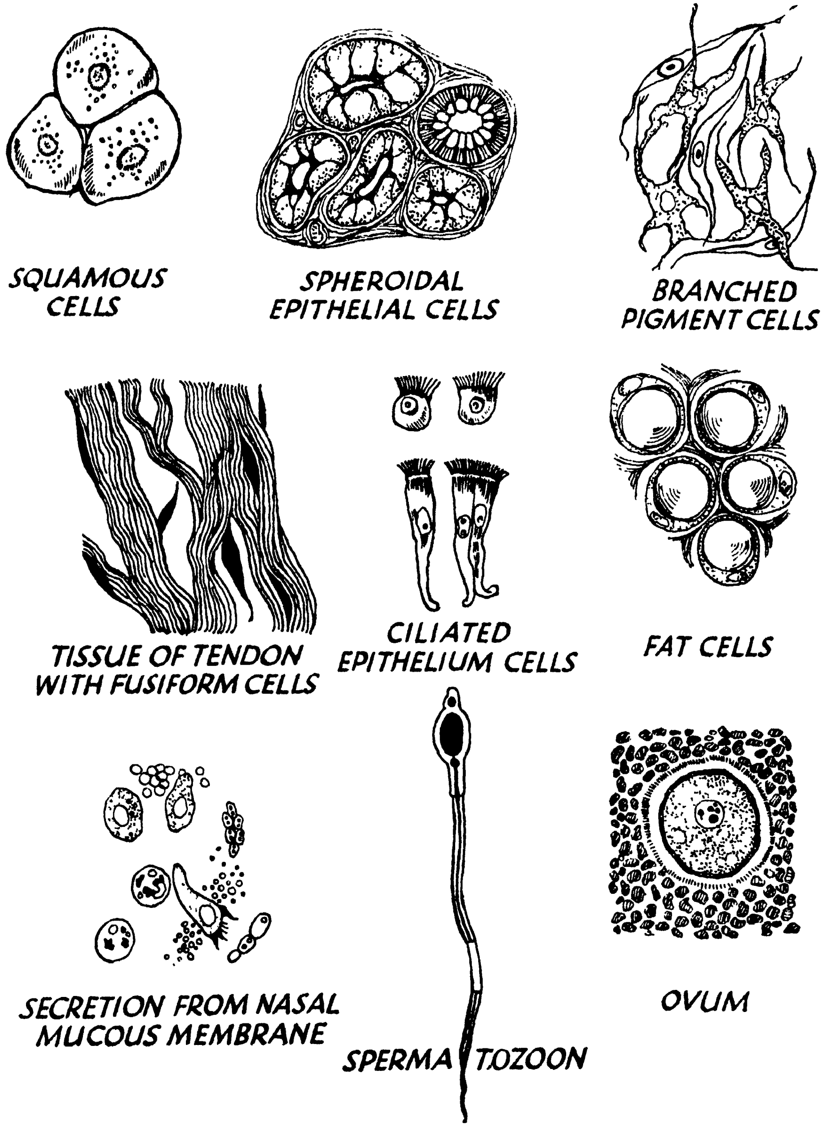
THE STOMACH AND DUODENUM

Besides the stomach, intestines, and liver, the abdominal cavity contains several other important organs. Two glands that play leading parts in the general working of the body are the spleen and the pancreas. The pancreas lies in the hollow between the lower side of the stomach and the duodenum, which is the name given to the first part of the small intestine. The functions of the pancreas are described in the section dealing with metabolism and the endocrine glands. The spleen lies on the left side rather behind the stomach, between it and the diaphragm. The function of the spleen seems to be to remove worn-out red corpuscles from the blood, to scrap them, and to prepare the utilizable ingredients for further service. It is believed that, if the spleen is removed, as it sometimes has to be on account of disease, the work hitherto performed by it is taken over by the liver; for it is a fact that life can be continued, usually with little inconvenience, in its absence. Below the stomach on the left, and the liver on the right, are the left and right kidneys, the latter being a little lower in position. Proceeding from the kidneys are the two tubes known as the ureters, which convey to the bladder the urine manufactured by the kidneys from the blood.

V—THE CELL: THE BODY UNIT

A WORD that again and again occurs in this book is 'cell.' Every living plant and animal is composed of conglomerations of minute particles, whole groups of which are practically identical in appearance and size. Man is no exception. These particles are so small that they can only be seen when highly magnified by the microscope. They are usually composed of a glutinous material, and sometimes are surrounded by a slightly tougher layer constituting a kind of wall or rind, known as the wall. Often, however, they have no such covering. The corpuscles that exist in the blood are examples of isolated cells; but our skin, our bones, our muscles, and our brain are all made up of tens of thousands of essentially similar cells, much as a wall or a pillar is often composed of bricks. Each cell contains a slightly differentiated core, known as the nucleus, embedded in the glutinous matrix already referred to.

Cells have the curious faculty of being able to divide themselves into two—each of the two new cells thus formed being usually indistinguishable from the parent cell. When a cell is about to divide, the nucleus becomes elongated, and its substance distributes itself into a number of infinitesimal rods, to which the name chromosomes has been given. The number of chromosomes in the cells is uniform in every cell forming part of the body of any given species of animal. When a cell divides into two the nucleus also divides, leaving each daughter-cell equipped with the full number of chromosomes. There is, however, one exception to this rule. In those species of animals, such as man, in which the individuals are of two sexes, the female, at certain stages of her development, produces at intervals reproductive cells or ova. The mother-cell of an ovum divides into two, as do other cells, but each cell thus produced is equipped with only half the usual number of chromosomes. Exactly the same phenomenon is found in the reproductive cells of the male, known as spermatozoa. A new individual is created when a spermatozoon unites with an ovum, which is then said to be fertilized. This new compound cell is furnished with the full complement of chromosomes, half of which are derived from the female germ-cell and half from the male germ-cell. Each one of us began his career as such a fertilized ovum. In suitable conditions this ovum divides into two, each of these halves again into two, and so on, until a mass of embryonic tissue is produced. At some stage of this development, agencies, about which as yet we know very little, cause a



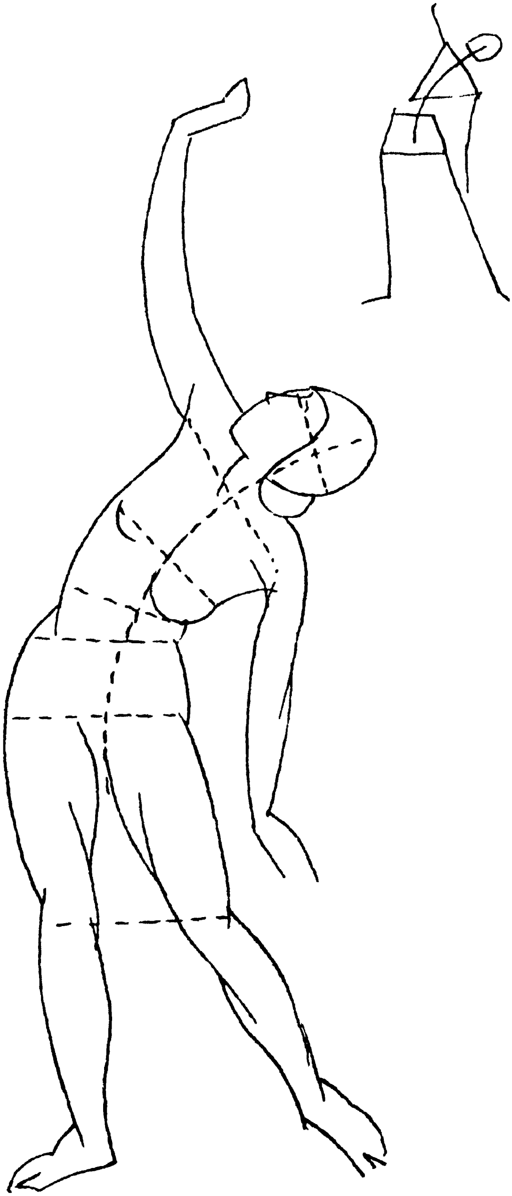
TYPES OF CELLS

differentiation to occur, so that certain daughter-cells no longer exactly reproduce the character of the cell from which they are immediately descended. Gradually organs and limbs begin to be formed, and these continue to grow until they reach a certain size, when further growth is checked. With our present knowledge we cannot, however, form an adequate idea of how this growth and development is organized and restrained within such clearly defined limits. At the end of nine months a new fully-formed human child appears in the world, equipped with arms and legs and eyes and ears and all the thousand specialized organs and tissues which go to make up the body of man. But this is not all the magic; for the infant, though without any first-hand experience of the world about it, begins straight away to exercise mind, and to make purposive movements calculated to secure its continued existence. Though it may not be what we call conscious, it already has knowledge. In simple ways it soon acts in a manner which in an adult we should attribute to reason. It grasps a support with its hands; it applies its lips to the nipple of its mother's breast. It has sensations and emotions—or, at any rate, acts in ways that we normally assign to such mental happenings. There is nothing in inorganic nature comparable with all this; and we may safely say that the difference between a living thing and an unliving thing is that the former possesses mind. We must not confuse this strange force or quality with any of our bodily structures, such as the brain or the nerves, important instruments though these are. Animals that have no stomach or intestines digest their food; creatures that have no lungs take in oxygen and give out their waste gases. Organisms that have no specialized generative organs reproduce their kind. Our organs but provide increased efficiency for our functions. Growth and differentiation continue for many years after birth, but ultimately there comes a limit to these processes. Growth ceases, and no, or very little, further differentiation occurs. A fuller account of cell division will be found in the chapter on Reproduction.

It may at this point be interesting to say something about the sporadic growth that takes place when a wound is healed. If we cut ourselves with a knife so that a gaping wound results, we soon notice certain well-defined signs and symptoms. Immediately around the wound is a redness, due to an increased flow of blood to the part owing to the tiny capillary vessels, normally either closed or but in part filled with blood, becoming fully dilated. Soon the cut surfaces are covered with a sticky substance, composed of fibrin and fluid exuded from the blood. Then multiplication of cells takes place at the sides and bottom of the wound, so that the gap gradually becomes filled with new tissue. In favourable cases, this growth ceases when the level of the adjacent skin has been reached, whilst the skin-cells round the new

tissue themselves begin to proliferate, until the wound has been completely covered. Occasionally, however, if the wound is a gaping one, and the two sides have not been approximated by stitching or otherwise, the central growth of new tissue does not stop when the skin-level has been reached, but proceeds beyond it, forming a protrusion which is commonly known as 'proud flesh.' Often this excess has to be got rid of before the skin will close over it. What has been described is the healing of a healthy or clean wound. The healing of a septic wound is not dissimilar, but there are added features. The congestion is more pronounced, and the exudation from the blood is greater—a large number of white blood corpuscles being brought to the wound to devour or otherwise kill the bacteria which are causing the trouble. As a result of the fight a collection of pus may be left on the battlefield. This fluid is a mixture of exuded lymph, liquefied tissue-cells, and dead corpuscles, with a certain number of bacteria, dead and alive. When a collection of pus is enclosed on all sides it is called an abscess, around which the healthy tissues and the blood have, more or less successfully, constructed an impervious wall, preventing the pus from escaping, and so contaminating the rest of the body. It is important, when an abscess is recognized, to make an opening into it from the outside, so as to allow the pus to escape. Otherwise it is liable to burst, or to worm its way through the defensive wall, and become distributed to other parts of the body.

The word 'tissue' has already been several times employed. Any collection of cells of the same kind, existing side by side, so as to form a mass, constitutes a tissue. Tissues of all the chief classes are found widely distributed throughout the body. Thus we have epithelial tissue, which is the kind found in the skin, the lining membranes of the mouth, stomach, and intestines, nervous tissue, muscular tissue, connective tissue, and so on. Several kinds of tissue are usually involved in the structure of what is called an organ—that is, a localized collection of tissues having special and peculiar functions, such as the brain, the heart, the liver, the spleen, and the kidneys.



THE SPINE AS AXIS

Most action round the loins

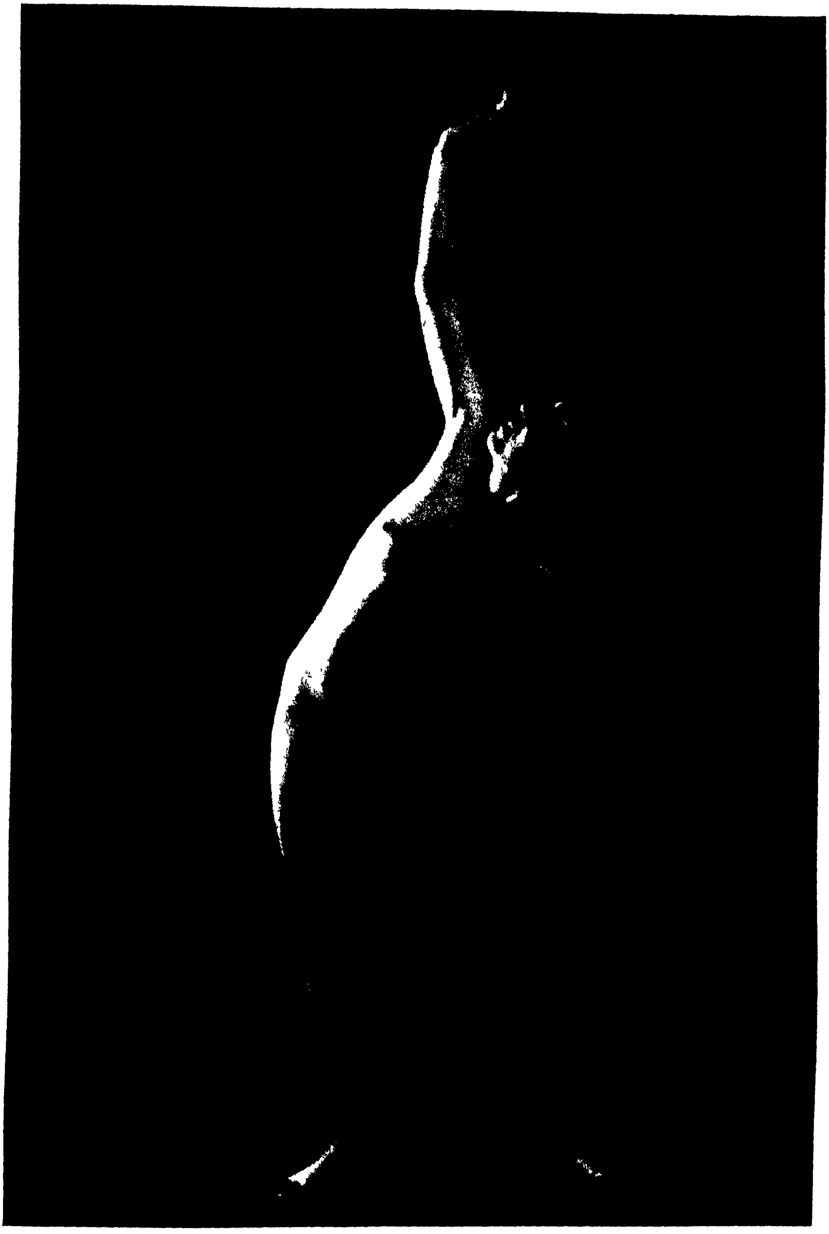


Photo by Herbert Williams

THE SPINE AS AXIS

Most action round the loins

VI—CIRCULATION AND RESPIRATION

In one minute the heart of that mythical creature, the average man, pumps out somewhere between seven to ten and a half pints of blood: that is, when he is at rest; in severe exercise anything up to six and a half gallons of blood may pass through the heart during the same time. It will thus be seen that the heart has considerable reserve power to meet emergencies.

Before the seventeenth century no one quite knew where the blood went to or what it was for. It was even thought that the arteries contained air. In 1628 the English physician, William Harvey, published his famous book proving that the blood went round in a circle—from the heart to the arteries, from the arteries to the veins, and from the veins back again to the heart. He did not know quite how the blood was carried from the arteries to the veins, for there were not in those days lenses powerful enough for him to see the capillaries; the diameter of one of these minute blood-tubes being about one two-thousandth of an inch. It was not until 1661 that the Italian physician, Malpighi, discovered these fine cylindrical vessels which connect the arteries with the veins. The circulation, then, involves the heart (the pump) and arteries, capillaries, and veins (the tubing). As this is to all intents and purposes a closed circuit, the same blood must be used over and over again.

The Anatomy of the Circulation

Certain points in the anatomy of the heart are considered in the section on diseases of this organ, and we will deal here only with those anatomical features of the heart and the circulation which are essential to an understanding of how they work.

The main function of the blood is to supply every cell of the body with oxygen, which is carried in combination with the haemoglobin in the red blood corpuscle. It will simplify matters if we follow the course of a red corpuscle which has just delivered up its oxygen to the biceps muscle of the arm. The oxygen passes from the haemoglobin into the lymph outside the capillary and thence to the muscle-fibre. Having done this, the corpuscle carries away the carbon dioxide which is one of the end-products of cell combustion. This exchange of gases takes place when the corpuscle is in the capillaries, which are so narrow that the

blood corpuscles move along them in single file. The carbon dioxide travels in the blood mainly in the form of sodium bicarbonate.

The red blood corpuscle, or, simply, red cell, then passes into a small vein, where it mixes with other red cells which also have given up their oxygen, and are bearing away carbon dioxide. (The presence of carbon dioxide gives the blood in the veins its blue colour.) The small veins run into larger veins, and the larger veins ultimately end in the two big venous trunks—the inferior and the superior venae cavae—which terminate in the upper chamber of the right side of the heart, called the right auricle. Our red cell from the arm has entered this auricle via the superior vena cava, and it passes from the auricle into the right ventricle—the lower chamber of the right side of the heart. When the right ventricle contracts the red cell travels by the pulmonary artery —the only vessel leaving this ventricle—to the lungs. The pulmonary artery divides again and again into smaller and smaller arteries, and finally into capillaries similar to those in the arm and in other parts of the body. Whilst in these lung capillaries, the red cell gives off its carbon dioxide to the air spaces of the lung, and once more takes up oxygen.

The carbon dioxide is expelled into the atmosphere when we breathe out, and fresh oxygen is taken into the lungs when we breathe in. Breathing, then, consists in supplying the red cells in the lung capillaries with oxygen, and in removing the waste product, carbon dioxide.

The red cell, now refreshed and pink, enters the small veins in the lungs, and these enter larger veins, whilst the larger veins collect into the big pulmonary veins which terminate in the left auricle—the upper chamber of the left side of the heart. From there the cell passes to the left ventricle, to be expelled when this contracts into the huge parent artery of all the arteries in the body—the aorta. The red cell once more carries on its duty of supplying the oxygen it has picked up in the lungs, maybe to the arm, or maybe to the big toe; once it has delivered its oxygen it takes away carbon dioxide and returns again via the veins to the right auricle and so back to the lungs.

The red corpuscle, it will be observed, travels through two circuits: a short circuit from the right side of the heart, through the lungs, to the left side of the heart; and a wide circuit from the left side of the heart, through the aorta, and many other arteries, to any part of the body, to end its journey finally in the right side of the heart.

There are two important divisions in this wider circuit. The venous blood that leaves the intestines is collected into a single vein which enters the liver, where it splits up into capillaries. These capillaries come into intimate contact with the liver cells, and deliver to them the foodstuffs collected from the intestines. The capillaries once more merge into veins, which leave the liver to enter the inferior vena cava.

The liver, then, intercepts the venous blood from the intestines on its way to the heart. The second important division is the circulation of blood through the kidney. The kidney is an extremely vascular organ, and it filters off from the blood passing through it excess water and salts and various poisonous products formed in the natural course of the body's working.

A red corpuscle lives for about thirty to forty days, and during this time it never stops working; when it dies it is replaced by another, manufactured in the bone marrow.

THE HEART.

When it is realized that the heart has to go on pumping out blood day and night, year in year out, and has to be ready to meet such emergencies as running for a bus or catching the last train home, in addition to supplying the constant needs of the body, it is evident that such a mechanism has to be very accurately adjusted, and at the same time relatively 'fool-proof' for any blood corpuscle that feels inclined to take the wrong turning.

The heart is a muscular bag, and the muscle-fibres are so arranged that when they contract the blood in this bag is, so to speak, squeezed out through the various openings in it. The bag itself is, as we have seen, divided off into four compartments by two partitions—one longitudinal and one horizontal. The openings into these compartments are guarded by valves, so that each can be shut off, when necessary, from its adjacent compartment. The right side of the heart is completely shut off from the left side by the longitudinal partition. The heart is itself supplied with blood from arteries (the coronary arteries) which come off at the origin of the aorta.

THE HEART-BEAT.

The heart beats, on an average, seventy-two times a minute. The contraction of the auricles lasts about one-tenth of a second, and that of the ventricles three-tenths of a second; the period of relaxation is about four-tenths; so the whole sequence of changes between the beginning of one beat and that of the next lasts about eight-tenths of a second. Although the right and the left side of the heart are separated from each other, the former containing impure blood loaded with carbon dioxide and the latter bright blood carrying oxygen, it must not be thought that during contraction of the heart the right side contracts first and the left follows after. What actually happens during the beat or contraction of the heart is that the two auricles (right and left) contract together, and then, after a slight pause, the two ventricles.

It will be simpler if we consider what happens on one side only—say the left. In the interval following one heart-beat the muscle

relaxes, gathering strength for the next. During this period blood which has exchanged its carbon dioxide for oxygen in the lungs is entering the left auricle from the pulmonary veins. Some of it flows through the opening between the auricle and the ventricle into the

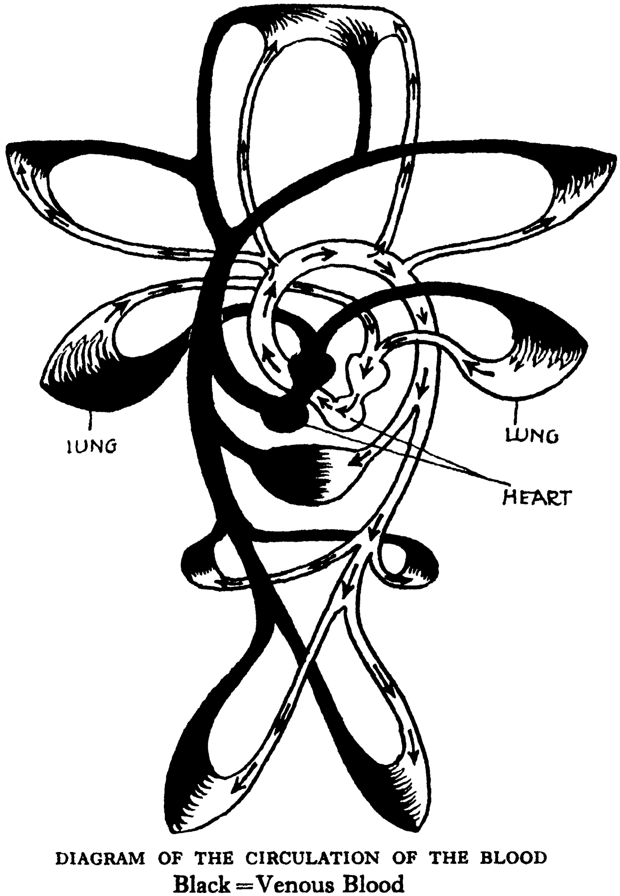


DIAGRAM OF THE CIRCULATION OF THE BLOOD
Black = Venous Blood
White = Arterial Blood

latter chamber, the muscular wall of which is relaxed. The auricle then contracts and expels the rest of the blood it contains into the ventricle. The ventricle now begins to contract, and the rising pressure within it forces into close contact the valve flaps which separate it from the auricle. For a short time it remains a closed chamber, until finally the pressure rises high enough to force open the valves which guard the opening of the ventricle into the aorta. The blood then shoots from the ventricle into this huge artery, and the increased

pressure in the latter which results from accommodating this increased quantity of blood shuts down once more the aortic valves.

These alterations in blood-volume and blood-pressure in the chambers of the heart and in the aorta, with the consequent opening and closing of valves, ensure that the blood goes in the right direction, and that there is no back-flow. If the valves are diseased, and so cannot close properly, leakage occurs, and the efficiency of the heart-pump is impaired. If the heart-muscle itself is damaged the driving force of the pump is diminished, and a more serious deficiency arises.

The above description applies to the cycle of events on the left side of the heart. A similar sequence is followed on the right. That is to say, when the left ventricle contracts and sends out its oxygenated blood into the aorta, the right ventricle contracts simultaneously and propels the carbon dioxide containing blood it has received from the veins of the body via the right auricle into the pulmonary artery, and so to the lungs to be purified. As the circulation of blood through the lungs is a much smaller affair than the circulation of blood through the whole of the body, the muscle of the right ventricle is about one-third the thickness of that of the left, because it has much less work to do.

HEART SOUNDS.

When the heart-muscle contracts it makes a noise, and this noise can be heard through the stethoscope as the first sound of the heart. This is followed by a second sound due to the closure of the aortic and pulmonary valves. These close when the pressures in the aorta and in the pulmonary artery are greater than the pressures in the left and right ventricles respectively, and indicate that the contraction of the heart is at an end, and the period of relaxation of the heart-muscle has begun. Alterations in the quality of these sounds occur in heart disease and inform the physician of what has gone wrong.

BLOOD-PRESSURE.

The aorta, we have seen, is the large artery that leaves the left ventricle. It soon divides into various branches which go to the arms, the head, and the neck. It then descends through the chest and enters the abdomen, where it gives off branches to the intestines and abdominal organs, and finally divides into the arteries that supply the legs with blood. The aorta branches out like a tree. The area covered by the branches is much wider than the area taken up by the main trunk, so that as the blood flows through this wider area the stream slows up and the pressure within the successive branches progressively lessens. (For example, the blood flows at the rate of about one foot a second in the aorta, and one inch a minute in the capillaries.) There is thus a steady fall of pressure from the heart to the smallest arteries.

When the heart beats and throws out a certain volume of blood into the aorta there is a rise of pressure in the arteries. When the heart rests in between the beats there is a fall of pressure. In order that the blood-flow may be steadily maintained all the time, the arteries have muscular and elastic tissue in their walls. During the contraction of the heart the increased blood-volume in the arteries is accommodated by the distension of the arterial walls, and the elastic recoil of these vessels after the contraction has ceased serves to maintain the pressure within them, and to ensure the continuity of the blood-flow; otherwise the blood would be pumped through the circulation in a series of intermittent spurts, and the cells of the body would be alternately exhausted and refreshed instead of having a constant supply of essential oxygen. The blood-pressure in a medium-sized artery, such as that in the upper part of the arm, is, during contraction (or systole) of the heart, equivalent to that required to raise a column of mercury about one hundred and twenty-five millimetres and, during relaxation (or diastole), about seventy-five millimetres.

THE CAPILLARIES AND THE VEINS.

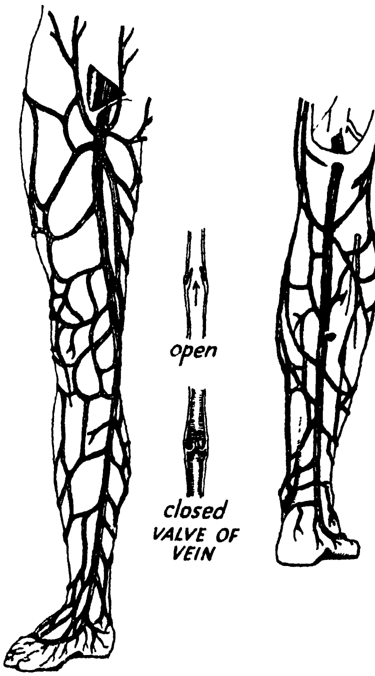
The capillaries are in direct continuity with the smallest arteries. A close network of these minute vessels permeates every tissue of the body; one square millimetre of muscle, for example, is penetrated by well over a thousand of these thin tubes, which have no muscular or elastic tissue like the thick-walled arteries, but are just one cell in thickness. In the capillaries the blood-stream widens out into millions of rivulets which feed every cell in the body with oxygen and food-stuffs. Not all these channels are open at the same time. If they were they would mop up the blood in the body as a sponge does water, the circulation could not be maintained, and death might ensue. It has been suggested that this is what actually does occur in the shock that follows severe injuries.

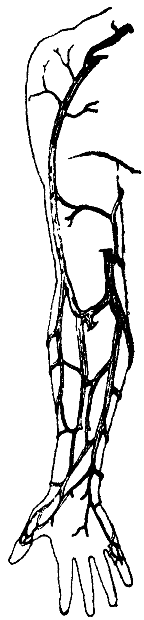
What happens is that the capillaries open and close according to the needs of particular tissues at particular times. For example, during muscular exercise there is a marked dilatation (widening) of the capillaries in the muscles; at the same time there is a narrowing and shutting down of the capillaries in the stomach and the intestines. In this way the blood is, so to speak, shunted off from the digestive system to the part where it is needed—the muscles.

The head of pressure in the arteries maintains the flow of blood through the capillaries, and by the time the capillaries have joined up with the veins the blood-pressure has fallen considerably. The blood-pressure in the veins continues to fall until the great veins enter the heart, and as the blood in a vein in the big toe has to travel about three-quarters of the length of the body to reach the heart there

must be some mechanism other than the arterial pressure to bring this about.

One of the most important factors in securing the return of blood in the veins to the heart is the suction action exerted by the movements of the chest, in breathing, on the greater veins (superior and inferior





VEINS OF THE ARM
Front view

VEINS OF THE LEG

venae cavae) within this cavity. Normally the pressure within the chest is negative. That is to say, if a hole were made in the chest wall the air from outside would rush in. When we breathe in, this negative pressure in the chest is increased and so sucks in blood from the veins outside it, for the veins are thin-walled and collapsible tubes, and do not have the thick, muscular, elastic walls of the arteries. During in-breathing (or inspiration) the diaphragm descends into the abdomen and increases the pressure within it, thus driving venous blood up into the chest towards the heart. The blood in the veins is prevented from going in the wrong direction (say back again towards the feet) by the presence of valves at intervals along their course.

Another factor in the propulsion of blood along the veins is the contraction of the muscles. During exercise this is particularly obvious.

WHAT MAKES THE HEART BEAT.

It used to be thought that nerves made the heart beat. But a frog's heart can be removed from a frog that has just been killed and it will go on beating for hours if it is kept at the right temperature, and in a suitable solution of salts. This and other evidence goes to show that the cause of the heart-beat is in the heart itself. It has been found that this automatic power of beating possessed by the heart-muscle is most marked in the region where the great veins enter the heart: the auricles, left to themselves, have a much quicker rhythm than the ventricles left to themselves; and they are much more irritable. This increased excitability and rhythmicity at the venous end of the heart determines the sequence of events in its contraction—auricles first, ventricles second—and so the blood goes in the right direction.

Not only do these properties exist in the heart-muscle, but the impulse to contraction is conducted from one chamber of the heart to the next by a special modification of the muscle. This is a different state of affairs from that which exists in, say, the biceps muscle: here the impulse to contraction passes down a nerve, and if the nerve is cut the muscle is paralysed. The heart, so to speak, regulates its own affairs as far as possible.

NERVOUS CONTROL OF THE HEART.

Nevertheless, the nervous system—the master system of the body—has an important part to play in co-ordinating the activity of the heart with the activity of the body, and supplies it with two sets of nerves: one set tending to slow the heart down (branches of the vagus nerve), and the other to quicken it (branches of the sympathetic nervous system). The sympathetic and the vagus nerves are not under conscious control. You cannot decide to quicken your heart as you can to quicken the movements of your leg muscles. Such individual freedom would be dangerous to so important an organ.

We know that if we get a sudden fright the heart starts to beat quickly—an effective preparation for flight from danger, for in flight more blood must be sent round the body and at a quicker rate, so as to supply the harder working muscles with oxygen. In broad terms, it seems that the sympathetic nervous system comes into action, quickening the heart and strengthening its action in times of emergency (running away, exercise, fighting), and that the vagus puts the brake on during rest so as to prevent it from overdoing things. These nervous activities are regulated by nerve-centres in the brain-stem, and from these centres impulses also go out along nerves which supply the blood-vessels, governing their state of contraction, and so regulating the blood-pressure according to the needs of the body. The nerve-centres in the brain are sensitive to chemical changes in the blood. An excess of carbon dioxide will stimulate the brain to send impulses along the

sympathetic nerve, and so quicken the rate of the heart. As an excess of carbon dioxide is produced during exercise this mechanism ensures automatically that the active muscles will receive more blood. At the same time the action of carbon dioxide on the brain results in an increase in the rate and depth of breathing, and this at the same time gets rid of the excess carbon dioxide, and brings a greater quantity of oxygen into contact with the capillaries in the lung. This delicate nervous and chemical control of the heart (and of the lungs) is so adjusted as to subserve the needs of the muscles of the body.

Respiration

Breathing is another bodily activity which is carried on automatically and, for the most part, unconsciously. As the muscles which control breathing are under voluntary control you can, of course, breathe quickly or slowly, or hold your breath, or blow things away from you. But you cannot do these things consciously for any length of time, nor can you control your rate of breathing, say, at the end of a hundred-yards race.

Essentially breathing—or respiration—means the exchange of the gases carbon dioxide and oxygen in all the tissues of the body. We have already seen that the blood from the veins gives up the carbon dioxide —one of the final products of bodily activity—to the air spaces of the lungs, and that the blood in the pulmonary capillaries takes up oxygen at the same time. The oxygen-carrying blood in the capillaries of a muscle delivers up its oxygen to the muscle-fibres, and carries away the carbon dioxide, so that respiration consists of two processes: the transport of the carbon dioxide from all the tissues of the body to the lungs, and so to the outside air; and the transport of oxygen from the air in the lungs to all the muscles and the organs of the body. The transport system is made up of the heart and the blood-vessels. These two systems, the respiratory and the circulatory, co-operate in the bringing of every cell in the body into contact with the air.

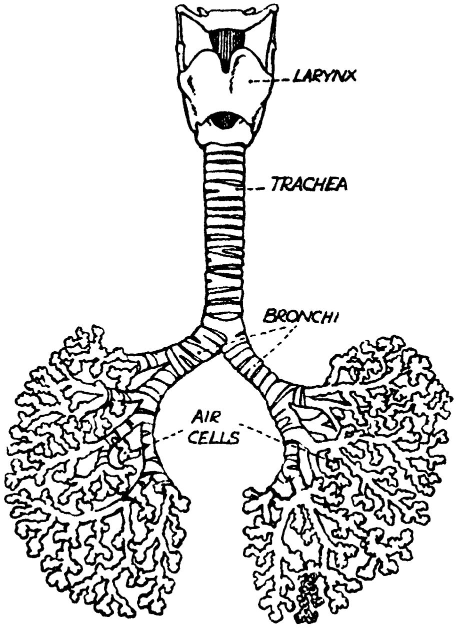
In order to make this possible Nature has evolved those enormous spongy masses, the lungs, which are honeycombed with little air pockets, each pocket being enveloped in a closely-woven network of capillaries. In this way an extensive layer of blood is brought into contact with a large volume of air. Between the blood in the capillaries and the air in the lungs only the thin walls of the capillaries and the thin walls of the air pockets are interposed.

THE ANATOMY OF RESPIRATION.

Broadly stated, the problem of respiration seems simple. But the human body is such an elaborate machine, and it has to work efficiently under such varied conditions, that different chemical and nervous

'tricks' have been evolved to safeguard the mechanism from being thrown suddenly out of gear.

Before considering these tricks we must look into the structure or anatomy of the air passages. Some account of this will be found in the section dealing with disease of the lungs. Briefly, the entrance to the air passage at the back of the throat is guarded by a thick valve-like structure, the epiglottis, which prevents food from going the wrong way. Below this is the larynx or voice-box or Adam's apple, which is simply a wind instrument for the production of sound. Below the larynx the trachea, or wind-pipe, strengthened with rings of cartilage (gristle), descends into the cavity of the chest to divide into the main bronchial tubes to the right and left lungs. These tubes (bronchi) divide and subdivide, like the branches of a tree, finally opening out into the air sacs or alveoli where the interchange of carbon dioxide and oxygen takes place. These alveoli are like thick clusters of grapes at the end of each small bronchus or bronchiole. Each alveolus is about half a millimetre in diameter, and is lined with large flat cells. Spread over its surface is a thick mesh of pulmonary capillaries.



THE AIR PASSAGES

The lungs are covered with a membrane, the pleura, which also lines the inside of the chest wall; and a thin layer of fluid secreted between these two layers of pleura enables the lungs to move easily within the chest during respiration. Separating the lungs from the abdomen is a strong muscular sheet, the diaphragm, which plays an important part in respiration. The ribs and the muscles attached to them are so arranged that during inspiration (breathing in) the chest can expand forwards and upwards and sideways. The diaphragm during inspiration descends into the abdomen, and so increases the vertical diameter of the chest cavity. In this way the chest acts as a bellows, and draws air into the lungs. Expiration (or breathing out) is mainly a passive recoil, for the elastic lungs tend to contract round their roots. By consciously drawing in your abdomen you can, however, forcibly expel air—as in coughing and sneezing.

The amount of air passing in and out of the lungs in normal quiet breathing is about five hundred cubic centimetres or thirty cubic inches. By taking a very deep breath about another hundred cubic inches can be taken into the lungs; and after a normal expiration about another hundred cubic inches of air can be forcibly expelled.

THE REGULATION OF RESPIRATION.

Respiration is carried on automatically day and night, year in, year out. This is an obvious but remarkable fact, looked at from the point of view of an engineer. Although voluntary muscles—muscles, that is, over which you have conscious control—perform the act, yet the automatism is involuntary; and it seems that this perpetual concertina movement of the chest is governed by groups of nerve-cells (nerve-centres) in the stem of the brain. These nerve-centres receive messages from various sources, and send out their instructions accordingly. There is a constant stream of messages going from the lungs up the vagus nerve during each act of breathing. This nerve, so to speak, informs the brain just what the lungs are doing, so that inspiration and expiration can be evenly balanced. It would not do if, for example, you continually took a short breath in and then a long breath out. Then, too, these nerve-centres respond to emotional stimuli: 'I was breathless with excitement,' you hear people say.

As the main function of respiration is to supply the body with oxygen and to get rid of carbon dioxide, we find that these brain-centres are very sensitive to abnormal quantities of these gases in the blood. An excess of carbon dioxide in the blood stimulates the nerve-centres in the brain to send out urgent messages along the nerves supplying the muscles which govern respiration, and breathing is quickened and deepened. This has the effect of getting rid of more carbon dioxide from the lungs and, of course, of bringing more oxygen into them. Now excess of carbon dioxide is produced when any extra exertion of the body is made, as in violent exercises; and this extra exertion requires more oxygen to complete the processes of combustion which provide the surplus energy required. So we see that this remarkable co-ordination between muscle, brain, lungs, and heart is to a large extent effected by the action of carbon dioxide on the nerve-centres. Thus the body utilizes this waste product to hasten the mechanism whereby not only the waste is itself expelled, but also more blood, and so more oxygen and food is brought to the service of the active tissues. It is an excellent example of the economy of co-operative effort.

This power of carbon dioxide to stimulate respiration is now being exploited by physicians in the resuscitation of infants suffering from asphyxia and patients who have been under an anaesthetic.

VII—METABOLISM AND FOOD UTILIZATION

In the broadest sense metabolism may be defined as the sum total of all the chemical processes which go on in the body. These chemical reactions have as their most obvious results the production of heat and movement, and it has therefore been the popular practice to compare the body to a sort of engine. This comparison, however, gives but a superficial picture of what is actually occurring in the body, as it takes no account of the facts that the body has to create suitable fuel from the food it absorbs and that it can use this for self-repair as well as for heat production. An engine, on the other hand, is supplied with fuel ready to be changed into energy, and has no power of automatic repair. Again, the fuel supplied to the animal organism can be transformed into forms of energy, for example, mental and reproductive energy, of which we have no counterpart in the inanimate world.

It used to be the practice to distinguish chemical from nervous action, but analysis of the phenomena presented has shown that even such apparently non-chemical activities as the nervous regulation of the heart-rate, or the contraction and dilatation of the pupil of the eye, are really effects produced by chemical agents formed in the body. It appears that all our bodily mechanisms are dependent for their proper functioning on the production of appropriate chemical substances, which act as stimuli or controllers; and on a proper condition of irritability of the organ which carries out the final act of the mechanism.

In the lower organisms, not provided with complex nervous systems, such a chemical regulation has long been recognized, but it is only in recent times that it has been realized that similar regulation occurs in the infinitely more highly organized and specialized higher animals. Let us take an example. The rate and force of the heart are among the most important phenomena in the body, for the proper supply of blood and therefore of oxygen to the muscles, brain, glands, etc., is thereby determined. Now the rate and force of the heart's contractions are normally under the control of certain nerves: one group, the vagus nerves, comes to the heart from the lower part of the brain, the medulla, and exerts a slowing action on the heart; another group, the sympathetic nerves, comes to the heart from the spinal cord, and exerts a hastening action on it. Stimulation of these groups of nerves can be carried out experimentally by various means; and when this is done to the vagus nerves the heart either slows or stops. It is an interesting fact that if

the blood coming from the heart after the vagus nerves have been stimulated is allowed to pass into another and normally beating heart it is found to possess the property of slowing or stopping the action of that heart. In fact, stimulation of the vagus nerves produces a substance which in its turn can stop or slow another heart. This substance, which has been identified as a complex chemical compound, called acetyl-choline, has resulted directly from the stimulation of a nerve; and it is found that injection of artificially manufactured acetylcholine into an animal produces the same effects on the heart as is caused by stimulation of its vagus nerves. The production of this substance goes on in the body normally, and is an example of what is included under the head of metabolism.

The special substances required for the control of metabolic processes in the body are in some cases produced by the activities of definite glands. Such a gland is the adrenal or suprarenal gland. And a short consideration of one series of events initiated by this gland will be instructive.

For metabolism to take place sugar must be present in the blood. This sugar is glucose, and will be dealt with in greater detail later. The amount of sugar in the blood varies during the day, but we may, at this stage, take as a roughly accurate figure a hundred milligrams per hundred cubic centimetres whole blood. If we take five litres as the total amount of blood in an average normal adult, the total glucose in the blood is about five grams. This level of blood sugar, as it is called, is maintained by the co-operation of several factors, but that of most importance in the present connection is a group of specialized brain-cells called the pons. Now it is known that emotional excitement increases the amount of sugar in the blood, in some cases doubling it. Analysis of this phenomenon has been going on for many years; and the sequence of events is now more or less understood. We are unable to present any physical picture of what constitutes the initial stimulus in the brain which sets in train the psychological condition known as emotion; but some form of energy is certainly liberated. Granted that such a state of energy liberation is initiated, impulses are transmitted from the higher centres in the frontal part of the brain which by various routes reach the cells in the pons just referred to. These cells having been stimulated, impulses pass down the spinal cord along special tracts, and emerge in the two nerves known as the splanchnic nerves, which partly control the activities of the liver, and probably completely control those of the adrenal glands. Part of the result is a stimulation of the adrenal glands, and as a consequence these organs secrete a substance called adrenaline into the blood. This substance possesses very active properties, among which is that of stimulating the cells of the liver to break down a complex substance, glycogen,

which is present in considerable quantities in the liver in normal circumstances. The breakdown or katabolism of glycogen gives rise to glucose, which passes into the blood, and thus raises the blood sugar. We thus have the following sequence of events:

Emotional excitement in higher centres.
↓
Stimulation of brain cells in pons.
↓
Passage of impulses down to adrenal glands.
↓
Liberation of chemical activator adrenaline.
↓
Stimulation of liver activity by adrenaline.
↓
Breakdown of liver glycogen to glucose.
↓
Rise in blood sugar.

This is a very much simplified picture of what actually occurs, but it will serve to indicate the importance of chemical activators of metabolic processes. Many such chemical activators are dealt with more fully in the chapter on the endocrine system.

The word 'metabolism' is often used in the more restricted sense of the sum total of the chemical changes which the food-stuffs undergo, i.e. intermediate metabolism, and of the energy which is obtained from each particular food-constituent. We speak of the metabolism of sugar (carbohydrate), of fat, of protein, and of mineral salts, when we wish to refer to the intermediate or ultimate fates of these substances, after they have been digested and absorbed. Digestion is an integral part of metabolism in ordinary normal life, but metabolism may take place without any digestive processes occurring in the intestine. Consider, for example, the case of a starving man after the first twenty-four or thirty-six hours of his fast. At this time the organism is receiving no food from the gastro-intestinal tract, but analysis shows that the blood contains all the substances which are present during normal life; that the urine contains those end-products which are the end-products of the utilization of protein and fat; and that the air breathed out contains the gas, carbon dioxide, which we know arises from the burning or metabolism of carbon. Metabolism, then, goes on during starvation. Such metabolism is called *endogenous metabolism*, to indicate that it proceeds at the expense of substances which are constituent parts of the organism itself, and to distinguish it from *exogenous metabolism* which proceeds at the expense of matter taken into the intestine.

Another example of the fact that metabolism does not necessarily involve digestion is given by an organism kept alive for long periods by the injection of nutrient matter directly into the circulation. This is, of course, an instance of exogenous metabolism. In such a case great care must be taken as to the nature of the matter injected. The familiar example of the life of the child before birth will at once suggest itself as an instance of metabolism proceeding without food entering the intestine, and sustained by products passing from the circulation of the mother into the circulation of the child.

What do the complex reactions of metabolism bring about? Normal metabolism makes food available for energy requirements, for growth, for the replacement of wear and tear of tissues, for reproduction and for the synthesis of vital internal secretions. A simple example or two will be useful. Milk, frequently called the perfect food, contains fat, protein, and carbohydrate; but, before these substances can be used by our bodies to produce heat or to produce new muscle or fat, a series of complex changes has to be gone through, so that the original milk loses its identity completely. In using milk for energy purpose, i.e. for the production of body heat, the organism does not burn milk, because the muscles, in which most of our heat is formed, cannot use so complex a substance. The organs, particularly the liver, have to deal with the constituents of the milk so as to prepare products with which the muscles can deal. Again, consider a person who eats too much, and over a period of years has gradually grown fat. Such a person is generally found to eat too much starchy or sugary food, or too much fatty food, or both. The transformation of starch or animal fat to human fat is no simple matter, and involves a very complicated chain of chemical reactions.

It is clear that metabolism will be different according to the conditions under which the organism exists. Thus, in the starving subject the processes of endogenous metabolism will represent a total loss to his body, and he will lose weight. In a growing child, on the other hand, the intake of food material must be such that his energy requirements are met, and that enough is left over for the formation of new tissue. In the normal adult the intake of food and the metabolic response thereto are usually just sufficient to balance the wear and tear incident to everyday life, and the weight remains more or less steady. The fact that normal adults keep their weight almost constant, in spite of considerable variation in the daily food intake, is one of the puzzles physiologists have not yet solved. It appears that, just as the heart can in time of necessity respond by doing more work, so metabolic processes can, if occasion arises, deal with more food material, and so keep the body-weight constant. How this is done, however, we do not know.

The study of metabolism has a quantitative as well as a qualitative side. We are able to measure the amount of energy produced in the body from the various constituents of the food taken, as well as to trace what the ultimate fates of these substances are.

Metabolic processes are divided into those which result in the building up of new body material and those which result in the breakdown of substances for energy purposes. The former are called anabolic changes, or anabolism; the latter are called katabolic changes or katabolism. An example of these types of metabolism will be useful. Sugar, when absorbed into the system may, according to circumstances, be completely broken down and burnt (oxidized) for the production of heat, or it may be built up to fat after first being split into simpler compounds. We therefore speak of the katabolism of sugar for energy purposes and the anabolism of sugar to fat. Such processes are going on side by side all the time, and it is the equilibrium between these processes which determines the state of nutrition of the body as a whole and whether or not growth is taking place.

We must now proceed to consider the nature of the substances which are metabolized by the organism.

WATER

One often loses sight of the fact that about 75% of the body is composed of water. All the reactions between substances occurring in the body take place in a watery medium, and the proper adjustment of water content in the tissues is an essential condition of normal physical life. Water is constantly being lost by evaporation from the sweat glands in the skin, by being carried out with the expired air, and by the secretion of urine. These processes would soon produce a great diminution in the water content of the body if fluid were not absorbed to replace the loss. Life is possible only if the protoplasm of the cells maintain a certain water content, and cannot continue for any length of time without renewed supply. Thirst is a much more serious matter than hunger, for, whereas more or less normal metabolism may continue for many days without solid food, it cannot without water. The period during which life can continue entirely without water varies with individuals and with external conditions. It must be remembered that all food-stuffs contain water, and also that in the metabolism of food for energy purposes water is produced. For example, if we were to eat a pound of absolutely dry starch, the body in disposing of it would produce rather more than half a pound of water, so that though the starch was quite dry it could not be said that the body was deprived of water. Similar results are obtained with absolutely dry fat or protein, as is seen in the following table.

Water produced from the metabolism of absolutely dry food

1 lb. starch produces rather more than ½ lb. water.
1 lb. protein ,, ,, ,, ,, ⅖ lb. ,,
1 lb. fat ,, ,, ,, ,, 1⅙ lb. ,,

To find out, therefore, how long a man may live without water it is also necessary for him to go without food. It is recorded that a certain Viterbi, a political prisoner, went on hunger strike, taking neither food nor drink, and survived for eighteen days. In tropical conditions this would have been impossible; death would have occurred in two or three days unless, as was done by a Mexican lost in the desert, the urine were drunk. During starvation the breakdown of the body's own material involves the liberation of a considerable amount of water, but this is insufficient to supply the necessary quota. Animals seem in general better able than man to withstand water deprivation.

Some idea of the amount of water lost by the lungs in the expired air and from the skin by perspiration is obtained when we consider that a man at rest in an atmosphere of medium humidity and at 23° C. loses some six hundred and eighty grams of water per day in these ways alone. This loss of water occurs mainly from the arms and legs, which account for some three-fourths of the total. It must be realized that the loss of water from the skin may not manifest itself as visible perspiration, but as what is called insensible perspiration. The rate of loss of water from the surface of the body being dependent upon the temperature and humidity of the surrounding air, it is clear that the demands of the organism for water will vary with the weather. The water which is lost in this way is carried to the skin in the blood, which contains about 80% water. Thus it follows that the more freely the blood enters the peripheral tissues the more readily will the processes of surface evaporation take place. In hot weather the peripheral small blood-vessels dilate and, if the surrounding air is relatively dry, large amounts of liquid are removed by evaporation and perspiration; but if the environment is moist very little liquid may be lost in this way. In cold, dry, calm conditions the surface blood-vessels contract and so less liquid reaches the skin in a given time, with a consequent diminished peripheral loss. In cold, dry, but windy weather the peripheral loss may be greatly increased as a result of the rapid removal of such water vapour as is formed. The consequently excessively dry layer of air near the skin stimulates the secretion of more perspiration, which is again rapidly removed. The change of the sweat from the liquid to the gaseous state takes heat from the body and from its immediate environment. The feeling of coolness we experience when exposed to a breeze even of warm air is due to the stimulus given to further evaporation from the body by the removal of perspired liquid or vapour.

The loss of body heat through the evaporation of water from the skin is one of the ways whereby warm-blooded animals keep the temperature of their bodies constant within narrow limits. The loss of water by the skin is also of great importance in helping to remove toxic substances from the organism, and the common practice of stimulating this process by drugs during a febrile disease is an application of this fact, although the main reason for inducing perspiration is to increase the loss of heat and thus lower the blood's temperature.

The principal route by which water is lost from the body in ordinary circumstances is, however, the kidneys. These organs are specially designed to remove from the body the end-products of metabolism. The urine is a very complex fluid which normally holds the waste products in solution in water; but it is a mistake to regard it as a simple solution of the same sort as a solution of salt in water. This is easily shown, for if clear urine be taken and its water removed by distillation at low temperatures, the residue of solid matter cannot be re-dissolved simply by pouring the distilled water back again. The conditions for solution in urine are provided by the body itself, and we are not yet clear as to the precise nature of these conditions. The secretion of urine is dealt with in another section, but it is relevant to point out here that the amount of fluid removed in the urine is greatly influenced by the activity with which fluid is being lost by the lungs and by the skin. Thus, when large amounts of fluid are being lost from the surface of the body the volume of urine may diminish very greatly; whereas, in cold weather, when much less loss takes place from the skin, more urine is secreted. The peripheral blood-vessels are contracted in cold conditions, and hence more blood is available for supplying the internal organs. An increased supply of blood to the kidneys induces a greater secretion of urine.

The following table gives an idea of the average daily amounts of water taken in by, and lost from, the body in normal circumstances.

Average total water exchange

Intake	c.c.	Output	c.c.
As beverages	1,450	In urine	1,500
In food	800	From the skin . .	600
Resulting from burning of food	350	From the lungs . .	400
		In the stools . .	100
	2,600		2,600

Such a perfect balance is only possible when the functions of the kidney and the heart are being normally carried out. In the event of defective function in these organs water cannot be excreted properly;

and, as a result, we get the condition of oedema, or dropsy, water accumulating in various parts of the body. The retention of water in the tissues leads to all sorts of disturbances in the muscles and elsewhere, particularly if there is a deficiency of salt as well. Miners, working in very confined spaces, perspire very freely, and tend to drink large quantities of water. But sweat consists of salt as well as water, and so the loss of large amounts of sweat involves a great loss of salt also, which latter is not replaced by simply drinking water. The result is that the muscles after a time become deficient in salt and too rich in water; a condition provoking contraction or cramp, known as miner's cramp. The cure is simple: if salt (10 grains to the gallon of water) is added to the drinking water, the symptoms disappear.

SALTS

By a salt we mean a substance which results from the interaction of an acid and a base. A salt, therefore, consists of two parts or radicles, an acid radicle and a basic radicle. Examples of salts of importance in biology are, sodium chloride, calcium phosphate, sodium bicarbonate, potassium chloride, potassium iodide.

It is hardly necessary to remind the reader that ordinary common salt, or sodium chloride, is essential to life. The relatively small amount of this substance in both animal and vegetable foods, further diminished by the loss which occurs in cooking, is appreciated by the body, and a desire for salt as a supplement to our meals is commonly experienced. But ordinary table salt is far from being the only salt in the body; and, although the want of the other salts is not so acutely felt as is that of common salt, their absence soon makes itself felt by disturbances in metabolism.

Metabolic processes are carried out by the activity of millions of cells; which structurally and functionally must be kept in a highly efficient state. The integrity of the body cells depends in large measure on the salt content of the fluids in which all the tissues are bathed. We have seen that the peculiar condition known as miner's cramp is due to a deficiency of salt in the tissue fluids. Another striking example of salt imbalance is the condition known as tetany. This disorder, which must not be confused with tetanus, may be brought about in a variety of ways. Its most characteristic feature is a striking hyperexcitability of the muscles, so that a stimulus ordinarily insufficient to produce a contraction will, if tetany is present, lead to violent spasms of the muscular system. It is found that in every case of tetany there is a deficiency of calcium salts in the blood and the tissues, and that the simple administration of calcium salts will often go far towards remedying the symptoms. It may, therefore, be concluded that the presence of a

sufficiency of calcium salts prevents an increased excitability of the muscles; proper muscle function is only possible if the body fluids contain a properly balanced mixture of salts.

In recent years much has been heard of the necessity of maintaining a supply of iodine in the body in order to prevent the appearance of certain forms of goitre or enlargement of the thyroid gland in the neck. In those countries where insufficient iodine is present in the food the necessary iodine is often given in the form of the salt potassium iodide.

The importance of an adequate ration of calcium and phosphorus salts in the diet of growing children in order to ensure the proper formation of bone cannot be over-stressed. Again, in order that the body may form haemoglobin, the red colouring matter of blood, it requires iron, and hence we use preparations of iron in the treatment of those forms of anaemia brought about by a deficiency of haemoglobin in the red cells. The necessity of iron salts is strikingly shown in the case of infants who have been kept for too long a time on a diet of milk, which is poor in iron. The infants develop an anaemia which is rapidly cured by giving them medicines containing iron salts.

It is well known that certain organs have been removed from the body and kept in a state of activity for a considerable time by driving an artificial 'blood-stream' through the arteries. By means of this procedure, which is called perfusion, we have been able to study certain properties of these organs hitherto unsuspected. Apart from many mechanical difficulties in this type of experiment, it is essential to use a perfusing fluid with a carefully adjusted composition. Oxygen also must be supplied in adequate proportions. The salts which have been found essential in order that the best functional results be obtained are: sodium chloride, potassium chloride, calcium chloride, sodium bicarbonate, sodium phosphate, magnesium chloride, and to these salts must be added the sugar glucose.

This short consideration may be sufficient to indicate that, although salts are not themselves energy producers, the power which the body cells possess to utilize food-stuffs depends upon these cells being bathed in a fluid which contains various salts in adequate amount, and in proper proportions. In other words, proper metabolism is only possible in a specially adapted medium.

Proteins

Proteins are complex chemical compounds, present in all living matter. They are composed of the elements carbon, hydrogen, nitrogen, oxygen, sulphur, and in some cases phosphorus. These elements exist in the protein in the form of relatively simple combinations called *amino-acids*, of which about twenty are known. These amino-acids

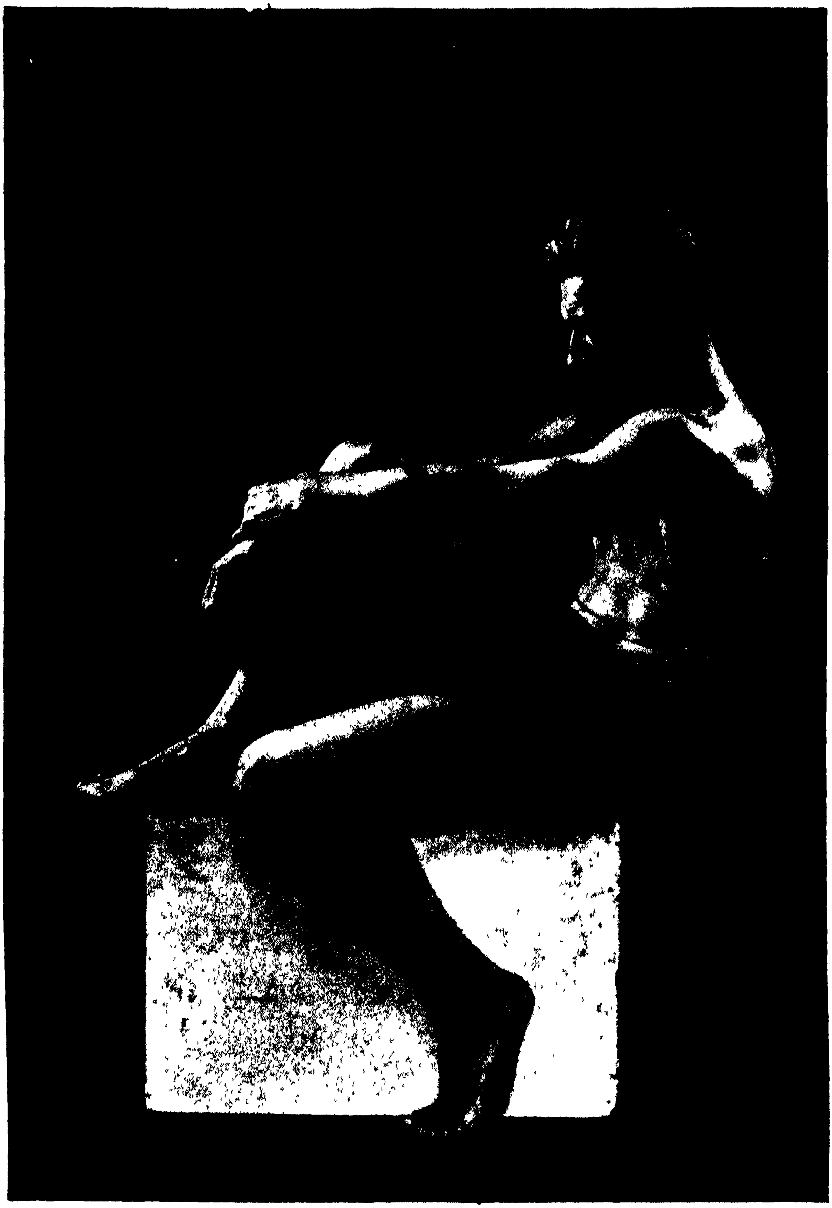
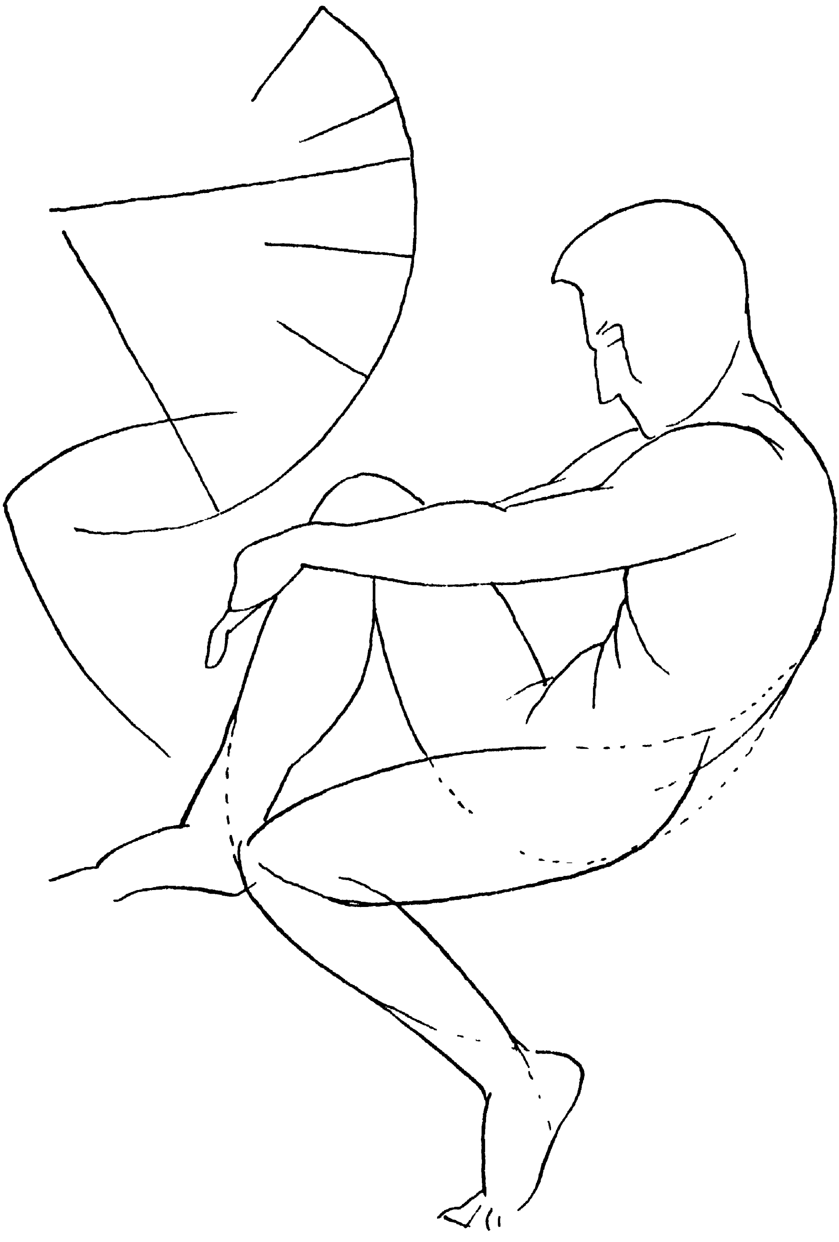


Photo by Herbert Williams

THE SPINE AS AXIS

Rhythmic movement of masses, governed by the curve of the spine. Here a convex curve



THE SPINE AS AXIS
Convex curve

are special combinations of organic acids and ammonia. Thus, acetic acid can in proper circumstances be made to react with ammonia to form amino-acetic acid, which is also called glycine, and occurs in the protein gelatine. Whilst the properties of these amino-acids are known fairly thoroughly, those of the proteins, which are chains of amino-acids linked together in a special way, are much more obscure.

Amino-acids are very often identifiable by tests more or less complicated and dependent on the reactivity of particular groups in the amino-acid molecule. There are, for example, three well-known amino-acids which consist of benzene compounded with other chemical groups, and are named phenyl-alanine, tyrosine, and tryptophan. These substances when treated with strong nitric acid, and boiled for a few seconds, give a yellow colour, and if the mixture be cooled and ammonia added the colour changes to orange. Now, if a protein solution gives a similar reaction, we conclude that it contains at least one member of the above three amino-acids. In this sort of way a large number of tests have been evolved by means of which we can say whether a protein does or does not contain a specific amino-acid or a member of a group of amino-acids. Such tests are chemical tests for amino-acids, and are very commonly used in the routine analysis of proteins. But such tests tell us nothing about the properties of the protein as a whole. By boiling the proteins with strong acids it is possible to break down the linkages and liberate the amino-acids so that they can be estimated quantitatively. This is very important for our knowledge of the constitution of the proteins, but it tells us nothing of the properties of the protein as a chemical individual.

The protein with which we are most commonly familiar is that contained in egg-white. Egg-white contains the proteins ovo-albumin and ovo-globulin, which, when examined in the natural state, appear fluid and rather sticky. The stickiness of egg-white is due to the presence of another protein, ovo-mucin. These proteins are present in what is called the colloidal state, and can be made to coagulate or solidify by being heated. Thus these proteins are called coagulable proteins. Egg-white is alkaline. If a little acetic acid be added to whisked egg-white, so as to neutralize it, and if then four or five times as much water as egg-white is poured on the mixture, a precipitate forms; this consists of ovo-mucin and ovo-globulin. The ovo-albumin remains dissolved. Thus we see that globulin is insoluble in water whilst the albumin is soluble.

Milk contains three proteins: caseinogen, which is rich in phosphorus, lact-albumin, and lacto-globulin. By adding acetic acid to milk a precipitate of casein—in which fat is entangled—is formed. Removal of the casein and fat leaves a turbid fluid which contains a globulin and an albumin. It must be realized that globulins and albumins differ in composition according to the source from which they are obtained; though they resemble one another in the group reactions. The albu-

mins from egg-white, milk, and blood serum are all different in chemical composition, containing as they do different amounts of the amino-acids per unit weight. For example, egg albumin contains 1·3% of trypto-phan (an amino-acid absolutely essential to normal metabolism), but milk albumin contains 2·7%; on the other hand the former contains 4% of tyrosine (another essential amino-acid), whilst the latter contains only 1·9%.

The proteins cannot as yet be classified by purely chemical means; we have to rely to a great extent on physical criteria, such as solubility in water, or alcohol, or acid, or alkali, or dilute salt solutions, and so on. The proteins of flour, for example, are called gliadin and glutelin. Gliadin is soluble in 75% alcohol, and glutelin is soluble in alkali. When water is added to flour, the familiar doughy sticky mass called gluten is formed; this is due to the action of water on the gliadin. Rice and oats, therefore, which are very poor in gliadin, do not give a dough with water. Again, gliadin contains over 40% of a certain amino-acid called glutamic acid, which by far exceeds the quantity of this substance present in the other proteins.

CONSTITUTION OF AMINO-ACIDS.

We have seen that proteins consist of chains of amino-acids linked together in a special way, and that the amino-acids result from a special combination of an organic acid and ammonia. We must examine shortly the structure of an amino-acid if we are to understand how it enters into metabolism.

'Organic' is the name given to the vast number of chemical compounds which contain carbon. This term has no reference to the presence of such compounds in the body, and in fact, the number of organic substances which are detectable in the body is small.

One class of organic compounds is that comprising substances which consist solely of carbon and hydrogen, and are, therefore, called hydrocarbons. The composition of such hydrocarbons is represented by formulae such as CH_4, C_2H_2, C_6H_6, the numbers referring to the number of atoms of the corresponding elements which are present in the molecule of the compound. The three formulae given are those of methane (marsh gas), acetylene, and benzene. Now the properties of hydrocarbons differ very widely according to the relative numbers of carbon and hydrogen atoms they contain, and it has been found convenient to classify them on such a basis. Thus the series of compounds which contain two more hydrogen atoms than twice the number of carbon atoms is called the paraffin series. Such a series contains the following members: CH_4, C_2H_6, C_3H_8, C_4H_{10}, etc. These formulae may for certain purposes be more conveniently written as follows:

$$\begin{array}{ccc} & H & \\ & | & \\ H- & C & -H, \\ & | & \\ & H & \end{array} \quad \begin{array}{cccc} & H & H & \\ & | & | & \\ H- & C- & C & -H, \\ & | & | & \\ & H & H & \end{array} \quad \begin{array}{ccccc} & H & H & H & \\ & | & | & | & \\ H- & C- & C- & C & -H, \text{ etc.} \\ & | & | & | & \\ & H & H & H & \end{array}$$

the carbon atoms being arranged in chains and each carbon atom having four links or bonds which are filled either by hydrogen or by attachment to a bond of another carbon. Carbon atoms have the important property of being able to hold in chemical combination four atoms of hydrogen or the equivalent of four such atoms. Thus we can substitute for one of the hydrogen atoms of methane one atom of the gas chlorine, and obtain CH_3Cl (the symbol Cl standing for one atom of chlorine), which is called methyl chloride, or, better, mono-chlormethane. If two atoms are thus substituted we get CH_2Cl_2, or di-chlormethane. Again, if we substitute the important group OH—called hydroxyl—for the hydrogen of methane we get CH_3OH, which is methyl alcohol; alcohols being partly characterized by the group OH. Similarly, by substituting OH for one of the hydrogens of ethane we get C_2H_3OH, which is ethyl alcohol, the alcohol of everyday use.

Now the group which is of particular interest to us in connection with amino-acids is the so-called carboxyl group, COOH, formed of one atom of carbon, two atoms of oxygen, and one atom of hydrogen. This group is characteristic of organic acids, and can only exist in combination with other groups. Thus, formic acid is H—COOH, acetic acid is CH_3—COOH, propionic acid is CH_3—CH_2—COOH, and so on. Acids so constituted are called fatty acids, and have a great importance in metabolism. The higher members of the fatty acid series, palmitic and stearic acids, when combined with glycerine, give the ordinary fats of the body. Acids containing in their molecule one carboxyl group are called mono-carboxylic acids; these as we have seen may be regarded as derived from the substitution of one COOH in the hydrocarbon molecule. If two COOH groups are thus introduced in the hydrocarbon molecule we obtain a di-carboxylic acid: an example of a di-carboxylic acid is $CH_2(COOH)_2$, malonic acid, which is obtained from the acid present in unripe fruits.

Let us now examine the chemical nature of the other constituent of the amino-acids, namely ammonia. Ammonia is a gas which is very soluble in water, giving a strongly alkaline solution. Ammonia consists of nitrogen and hydrogen chemically united, and its chemical formula is NH_3. The atomic weight of hydrogen is taken as 1, and that of nitrogen is found to be 14; hence the molecular weight of ammonia is 17, so that 17 parts of ammonia contain 14 parts of nitrogen.

Now if we take a fatty acid, say acetic acid ,CH_3COOH, and make it react with ammonia by special methods (mere addition of ammonia to acetic acid will not do), a compound is obtained of the following structure:

$$\begin{array}{rcl} & H & \\ & | & \\ H— & C & —COOH \\ & | & \\ & NH_2 & \end{array} \quad \text{or} \quad CH_2—NH_2—COOH$$

i.e. the acetic acid and the ammonia have joined together with the loss of two hydrogen atoms. Such a compound is called an amino-acid. The particular one given is called amino-acetic acid or glycine. Propionic acid and ammonia give amino-propionic acid or alanine, CH_3—CH—NH_2—COOH. Amino-acids may contain one NH_2 group, or two such groups; and the amino or

NH_2 group may be present in a mono-carboxylic acid or in a di-carboxylic acid.

Several other groups than the simple fatty acid may enter into the composition of an amino-acid, but these will be referred to as they become relevant.

THE PROTEIN LINKAGE.

It has already been pointed out that proteins are built up of chains of amino-acids, and it will be convenient to examine now how this linkage occurs. The justification of the assertion that amino-acids are linked in this way is mainly based on the fact that substances formed by the chemist using this method possess properties very similar to those of proteins.

Let us take the two simplest amino-acids, viz., amino-acetic acid and amino-propionic acid, and link them together in the way they are probably linked together in the protein molecule. We write the formulae in such a way that the process is easily followed.

$$\begin{array}{ccccc}
 & CH_3 & & & CH_3 \\
 & | & & & | \\
CH_2—COOH & NH_2—CH & \longrightarrow & CH_2—CO—NH— & CH \\
| & | & & | & | \\
NH_2 & COOH & & NH_2 & COOH
\end{array}$$

Amino-acetic acid (Glycine) | Amino-propionic acid (Alanine) | Glycyl-alanine

What happens is simply that the carbonyl group (COOH) of one acid reacts with the amino group (NH_2) of the other acid, and by the elimination of the group H_2O, which is really water, a new group, CO—NH, is formed in the middle of the new compound. Such a compound of two amino-acids is called a di-peptide; the names given to such substances are formed according to the common names of their constituent amino-acids. If three are linked together the result is a tri-peptide, and the general name given to this class of compound is poly-peptide. Proteins consist of chains of polypeptides formed from some twenty amino-acids; this gives us some idea of the complicated nature of these constituent elements of living matter.

METABOLISM OF PROTEINS.

The organism on being presented with protein in the diet is faced with several problems. It has got to break down the protein into its constituents amino-acids, then absorb them into the circulation, and so deal with them that new tissue may be built up to replace wear and tear. In addition, it has got to synthesize the necessary internal secretions from the amino-acids, and also make a proportion of the amino-acids available for energy purposes. The preparation of the proteins for metabolism begins in the stomach and small intestine, and is described in the section dealing with digestion. For our present purposes it can be shortly stated that the digestion of protein

consists in a series of complex reactions taking place in the gastro-intestinal tract, and has for its object the breaking of the linkages which hold together the amino-acids in the protein, and so free them that they can be absorbed into the blood. Diet protein is only of use to the organism in so far as it can be broken down into amino-acids.

The amino-acids having been absorbed, a complex series of changes occur, of which our knowledge is in many respects fragmentary. Certain matters, however, seem to be relatively clear.

If a protein is to be of value in the building up of new tissue it must contain among its amino-acids the following three: phenyl-alanine, tyrosine, and tryptophane, because the manufacture of new protoplasm is impossible without these substances. Consider the familiar protein, gelatin, obtained by boiling animal connective tissues with dilute acids. It is so poor in tyrosine and tryptophane that as an exclusive source of protein it is useless.

The adult organism must be considered as being in a state of complex equilibrium, and one of the indices of this equilibrium is the relation between the amount of nitrogenous matter which is absorbed and the nitrogenous waste matter which is excreted. Compounds containing nitrogen are constantly found in the urine and faeces of animals and of man. Whether food is taken or not, nitrogenous compounds are excreted. We can speak of protein metabolism as nitrogen metabolism, since fats and carbohydrates do not contain nitrogen. Any nitrogenous compounds in the urine and faeces must come from protein metabolism. So, during starvation, the amount of excreted nitrogenous matter will be a measure of the amount of tissue protein that is being broken down or katabolized; this will give us a good idea of how rapidly a fasting man is going down hill. During normal dietary conditions the amount of nitrogenous matter excreted over a period is equal to the amount absorbed; or, put in another way, the amount of nitrogen in the excreta is equal to the amount of utilizable nitrogen in the food taken over the same period. When this is the case the subject is said to be in *nitrogenous equilibrium.* If, however, the protein eaten does not contain the essential amino-acids above referred to, no amount of it can bring the body into this state of equilibrium. So, if the sole source of protein is, for example, gelatin, nitrogenous equilibrium cannot be attained, and the essential amino-acids for repair will not be available.

From these facts we may enunciate the general proposition that *Nitrogenous Equilibrium cannot be attained unless certain amino-acids are present in the diet.* In addition to the three already mentioned, the following three are also to be included in the essential amino-acids, since the body appears unable to synthesize them: histidine, lysine, and a very important one called cystine, which contains sulphur.

Existence on a diet which is deficient in these amino-acids is not unlike starvation.

The conception of nitrogenous equilibrium brings us to the peculiar power which the body possesses of adjusting itself to different conditions of protein intake. If the diet of a man is so arranged that he receives a considerable excess above his requirements, it is found after a few days that his metabolism is so adjusted that he is again in nitrogen equilibrium, i.e. his tissues soon learn to deal with the excess food protein and his processes become keyed up to a higher level than before. The reverse process of keying down to a lower level of nitrogenous metabolism occurs if we then lower his diet to the former quantities.

DE-AMINATION OF AMINO-ACIDS.

We must now see how the body deals with the amino-acids which it absorbs from the digestion of protein. There is much in this process which scientists are very doubtful about, and the description here given will be the barest outline of it.

It must be conceived that at all times there is a greater or lesser stream of amino-acids in the blood. These amino-acids may be coming from the protein digested in the intestine or from the breakdown of the body's own protoplasm, and their fate will vary according to the necessities of the moment. If there is a need for repair of tissues, those parts in need of repair are able to draw on the blood and tissue fluids for the necessary amino-acids. If there is a need for energy-giving material, the tissues (muscles, heart, kidneys, etc.) will draw on the same source, but in the latter case the amino-acids must go through a special process before they can be available for use. This special process has for its object the separation of the nitrogen-containing part of the amino-acid from the fatty acid part, and is called de-amination.

De-amination can probably occur in most tissues in the body, but it takes place mainly in the liver. The amino-acids reach the liver through its blood-supply, and come into intimate contact with the complicated system called the liver cell. Here they are acted upon by peculiar agents called enzymes. All we can say about enzymes here is that they are substances produced by living cells, and that they have the property of making biological reactions occur at a great speed. The changes undergone by food in the stomach and intestine depend largely upon enzyme action. If we had to rely on ordinary chemical means to effect the necessary changes in food, it would take much longer to produce the same effects. Enzymes may be looked upon as the tools used by living cells to bring about rapid chemical changes so that the body may be supplied with necessary and suitable material. One example of a familiar enzyme will have to suffice here. Yeast, which

consists of living cells, produces an enzyme which is called zymase. Yeast cells can live on sugar, and in doing so they use their enzyme zymase to split up the sugar molecule. This splitting or fermentation of the sugar gives the yeast its energy and gives us, as a sort of by-product, alcohol. One additional point must be borne in mind. There are a large number of enzymes, and it is a very strange fact that they are specific in action, i.e. each enzyme will act on a particular substance, and no other.

The liver is richly supplied with a whole host of enzymes, and among them are some the special function of which is de-amination. Whatever the intermediate stages may be, the final result is to produce from the amino-acids ammonia and a fatty acid derivative.

$$\text{AMINO-ACID} \xrightarrow[\text{Enzymes}]{\text{Liver}} \text{AMMONIA and FATTY ACID DERIVATIVE}$$

The fatty acid derivative may be regarded as undergoing changes similar to those described in later sections; the ammonia liberated must here be examined more closely.

The ammonia as soon as it is liberated combines with carbon dioxide, which is always available in the tissues, and forms ammonium carbonate. The ammonium carbonate is then broken down in two stages to form a very important substance, *Urea*.

AMINO-ACID ⟶ AMMONIA ⟶ AMMONIUM CARBONATE ⟶ UREA.

Urea is a white crystalline substance, and is very soluble in water. It contains 47% of nitrogen, and constitutes between 80 and 90% of all the nitrogenous waste matter in the urine. About thirty grams (28 grams are equal to 1 ounce) of urea are excreted per day by a normal man on an average diet. Urea appears to be quite useless to the animal body, and is excreted by the kidneys soon after it is formed in the liver. It is always present in the blood and tissue fluids, thus indicating that protein metabolism is always going on.

In normal circumstances all the ammonia split off from the amino-acids is changed into urea; but if there is disease of the liver this change may be carried out inefficiently, so that ammonia accumulates—or there may even be an accumulation of amino-acids due to failure of de-amination.

In certain diseases characterized by an abnormal production of acids in the tissues (e.g. in diabetes) the body uses the ammonia of de-amination for neutralizing these acids, so that less urea is formed, and more ammonia is found in the urine. In conditions where there is a tendency to alkalinity (e.g. in continued vomiting), all the ammonia is changed into urea, and hardly any can be detected in the urine.

The metabolism of protein may be summed up in the following scheme:

Food protein

Digestion in the gastro-intestinal tract

Tissue protein

Breakdown to amino-acids

Amino-acids carried to liver and tissues

De-amination, mainly in the liver

Repair of tissue

Ammonia

Ammonium carbonate

UREA

Fatty acid derivative

(See Fat Metabolism)

Fat Metabolism

The fats are compounds of glycerine and higher fatty acids. Glycerine is rather like an alcohol in chemical structure, and one molecule of it can combine with three molecules of fatty acid, the result being a fat or an oil. Fat is insoluble in water, as is readily seen if whole milk is allowed to stand, when the cream (18% fat and 75% water) rises to the top as a separate layer. Fat is lighter than water. Cream is an emulsion of fat in water, i.e. the droplets of fat are suspended in a watery medium. The churning process changes the cream so that the water globules are now suspended in a fatty medium. Butter (81% fat and 11% water) may be regarded as a suspension of water in fat.

The emulsification of fats is a very important process in their digestion. It consists mainly in the splitting up of the fat into such small globules that they can remain in suspension for a very long time. Fats may be of vegetable or of animal origin.

The emulsified fat passes into a system of fine vessels called lacteals,

which arise from the inside of the intestine. These tubes swell up and become full of a milky fluid when fat is being absorbed. The fat is carried by means of the lacteals to the blood, and it is easy to recognize an increase of fatty globules in the blood during active digestion. The fat is distributed by the blood to all parts of the body where, according to circumstances, it may be oxidized (i.e. burnt for energy purposes), stored, or changed to other substances needed by the organism.

STORAGE OF FAT.

This will occur when the amount of fat taken in the diet exceeds the needs of the organism. The fats of different animals differ in composition; so that, if we eat butter, which is bovine fat, or mutton or pork fat, important changes have to be effected in order that human fat may be formed.

The fat which is laid down in our bodies does not necessarily arise from fat as such. We have seen that fatty acid derivatives arise during the metabolism of protein, and such compounds can lead to fat deposition. Animals can be fattened even on a diet of almost fat-free food; especially if the diet contains a great excess of sugar. Starch or sugar is, indeed, the main source of fat in most obese individuals.

As has been said before, fats contain no nitrogen; they consist entirely of carbon, hydrogen, and oxygen; hence the body cannot be sustained on fat alone. Fortunately, the forms in which fat is usually eaten include considerable amounts of protein. The Eskimos, who eat large quantities of fatty substances because of their high heat value, have to supplement their diets with protein matter such as fish or flesh.

FAT-LIKE SUBSTANCES IN THE BODY.

In addition to the ordinary fats, the body also contains other substances resembling fats, the functions of which are imperfectly known. These bodies are called lipoids; and they consist of combinations of fats, phosphoric acid, and a complicated substance called choline. These lipoids are found in almost every tissue in the body. We have referred to a derivative of choline, viz. acetyl-choline, as being the agent responsible for the inhibition of the heart; and it may be that the lipoids have some intimate relation to the function of nerves, for nervous tissue is particularly rich in lipoids. Egg yolk is also rich in these compounds.

OXIDIZATION OF FATS.

The main value of fat to the organism lies in the great amount of energy or heat which can be obtained from it. Weight for weight, we

get more than twice as much heat from fat as from protein or sugar. This heat is made available by 'burning' the fat, that is, by oxidizing it. As has been said, fat consists of glycerine and fatty acids, and the only elements involved are carbon, hydrogen, and oxygen. The oxidization of fat may be thus expressed:

$$\left.\begin{array}{c}\text{FAT}\\ \text{OXIDIZATION}\end{array}\right\} \begin{cases}\text{Glycerine} + \text{Oxygen} \longrightarrow \text{Carbon dioxide} + \text{Water}\\ \text{Fatty acids} + \text{Oxygen} \longrightarrow \text{Carbon dioxide} + \text{Water}\end{cases}$$

The 'engine' in which this occurs is the body, and in normal conditions there is no 'smoking,' i.e. the fat is completely converted into the gas carbon dioxide and the liquid water. This kind of burning or complete combustion is possible outside the body only at a high temperature and in the presence of a free supply of oxygen, otherwise compounds are formed as a result of incomplete combustion. Such products will readily be detected if fat or oil is thrown on to a hot plate or pan. In certain circumstances the body also burns fat incompletely, but we will return to this later.

How does the body completely oxidize the fat? Does it simply take the fat molecule, break off the carbon, and burn it to carbon dioxide, and do likewise with the hydrogen, and use the oxygen in the fat as best it can? Whilst in a certain sense this is what it does, the process is by no means so direct a one as such a description would suggest. As in the case of protein metabolism, we will give a simple view of the breakdown of the fat molecule in the body.

The tissues, especially the liver, possess enzymes which can split the fat into its component parts, glycerine and fatty acid, and these are then dealt with more or less separately.

METABOLISM OF GLYCERINE.

Evidence as to how the body deals with glycerine is conflicting, but it is probable that a good deal of it is changed into a sugar (glucose) before it is burnt away. Keeping in mind what was said about fatty acids and their chemical formulae, it should be easy to understand the following: Glycerine is

$$\left.\begin{array}{l}CH_2OH\\ CHOH\\ CH_2OH\end{array}\right\} \text{ or } C_3H_8O_3, \begin{array}{c}\text{and in the body this}\\ \text{readily changes to}\end{array} \left\{\begin{array}{l}CHO\\ CHOH\\ CH_2OH\end{array}\right\} \text{ or } C_3H_6O_3.$$

The latter compound is called glyceric aldehyde, and two molecules of it can join together and form one molecule of the sugar glucose, the formula of which is $C_6H_{12}O_6$. Now glucose is a sugar which the body readily metabolizes, so the problem of the oxidization of glycerine becomes that of glucose (see next section). It is interesting to remember this because one-fifth of the weight of fat is glycerine, and so it appears that when we talk of the

metabolism of fat we are automatically forced to consider the metabolism of sugar.

METABOLISM OF FATTY ACIDS.

The fatty acids occurring in the body are characteristic in that they have an even number of carbon atoms in the molecule. Fatty acids are known which have uneven numbers of carbon atoms, but these do not occur in the body. The three important fatty acids recognized in animal fats are the following:

Stearic acid,	Oleic acid,	Palmitic acid;
$C_{17}H_{35}COOH$	$C_{17}H_{33}COOH$	$C_{15}H_{31}COOH$

their structure is better represented in chain form:

$$\begin{array}{r*{17}{c}l}
 & H & H & H & H & H & H & H & H & H & H & H & H & H & H & H & H & H & \\
 & | & | & | & | & | & | & | & | & | & | & | & | & | & | & | & | & | & \\
H- & C- & C- & C- & C- & C- & C- & C- & C- & C- & C- & C- & C- & C- & C- & C- & C- & C & -COOH \\
 & | & | & | & | & | & | & | & | & | & | & | & | & | & | & | & | & | & \\
 & H & H & H & H & H & H & H & H & H & H & H & H & H & H & H & H & H &
\end{array}$$

is stearic acid, and palmitic acid is simply one group CH_2 shorter. Observe that each carbon in the chain has four links all fully occupied. In order to make a similar formula for oleic acid it is necessary to leave two of the carbon links unfilled, and we express this unfilled condition as follows:

$$\begin{array}{cc}
-C= & C- \\
| & | \\
H & H
\end{array}$$

the double link or bond indicating that each carbon atom is potentially able to combine with another hydrogen atom or its equivalent. Fatty acids in which no double bonds occur are said to be saturated; those in which such double bonds do occur are said to be unsaturated. In general, compounds which have double bonds are more reactive chemically than those which have no such bonds.

When presented with the problem of metabolizing a fatty acid the body uses two main stages:

(1) The fatty acids are dealt with in the liver and de-saturated, i.e. hydrogen atoms are split off the chain, and new acids are formed with more double bonds than the original acid.

(2) The de-saturated acid is now subjected to a process by which two carbon atoms at a time are split off the fatty acid chain. In this way the fatty acid is 'niggled' away. The 'niggling' begins at the end with the carboxyl group in the following way:

$$\begin{array}{l}
CH_3—CH_2—CH_2— \ldots CH_2—CH_2—COOH \text{ i.e. } C_{17}H_{35}COOH \\
\qquad\qquad\qquad\quad \downarrow \\
CH_3—CH_2—CH_2— \ldots CH = CH —COOH \text{ i.e. } C_{17}H_{33}COOH \\
\qquad\qquad\qquad\quad \downarrow \\
CH_3—CH_2—CH_2— \ldots COOH\ \ CH_3COOH \text{ i.e. } C_{15}H_{31}COOH+CH_3COOH
\end{array}$$

This is a rather arbitrary way of representing a very complex process, but it will serve to present the principle involved. Each stage of the process

yields one molecule of acetic acid, and leaves a fatty acid with two carbon atoms less than the preceding one contained. Thus, since the fatty acids in the body always contain an even number of carbon atoms, the whole molecule can be considered as split up into molecules of acetic acid. The oxidation of the fatty acid molecule is thus resolved into the disposal of acetic acid. One well-known worker on this subject has said that the oxidation of fatty acid by the body consists of a series of micro-explosions of acetic acid. We must conceive that each molecule of acetic acid as it is formed undergoes immediate oxidization to carbon dioxide and water. In this way the fatty acid molecule is normally completely disposed of without residue.

CARBOHYDRATE METABOLISM

Carbohydrates are so called because they consist of carbon, hydrogen, and oxygen, the last two elements existing in the molecule in the proportions in which they occur in water. The carbohydrates of importance to us are the following:

Starch is a carbohydrate of vegetable origin, and is the form in which carbohydrate is stored in the plant. Starch is readily changed into glucose by the action of certain enzymes—ptyalin in saliva, and amylase in the secretion of the pancreas.

Glycogen might be called animal starch, and is the form in which the body stores carbohydrate, so that it may later be changed into the utilizable form of glucose. Glycogen is found in almost every tissue in the body, but is especially rich in the liver, the muscles, and the heart.

Cane Sugar is the sugar of everyday use, and is quickly changed in the intestine by means of the enzyme sucrase into two sugars, glucose and fructose. These have the same chemical formulae; but the arrangements in the molecule are different, and they have different properties. For example, fructose is sweeter than glucose, and is more soluble in water.

Lactose is the sugar of milk. On absorption into the intestine it is acted upon by a specific enzyme, lactase, and changed into two sugars, glucose and galactose, before entering the blood. The production of lactose in the milk of the breast does not depend on the lactose taken by the mouth; it is synthesized by the breast-gland in some unknown way from the sugar in the blood, glucose.

Glucose is the sugar of the blood. It is also the sugar of the grape. The body readily uses it for energy purposes. It is constantly being liberated from glycogen in the liver, and carried to the blood and tissues.

TWO IMPORTANT PROPOSITIONS.

(1) The whole cycle of normal metabolism depends on the proper metabolism of glucose. The whole metabolic machine goes wrong if the metabolism of glucose goes wrong.

(2) Normal glucose metabolism depends on the proper production of glycogen. Failure to form glycogen in the body leads to abnormal carbohydrate metabolism.

Let us suppose that some starch is taken by mouth, and let us follow it through the principal stages which occur in its metabolism.

Stage 1. The starch is acted upon in the mouth by the salivary enzyme ptyalin. The starch is felt to become somewhat sweet owing to the change to maltose or malt-sugar, which is brought about by the action of the enzyme on the starch. The maltose and unchanged starch pass into the stomach, where the ptyalin becomes inactive owing to the acid which is produced in the stomach. This acid may to some extent itself promote the change to maltose.

Stage 2. The maltose-starch mixture now passes to the small intestine, where it meets two important enzymes, which complete the change of starch to maltose, and further change the maltose to glucose. These two enzymes are respectively amylase produced by the pancreas, and maltase produced in the glands of the intestinal wall. The starch is thus all converted into glucose, and this is rapidly absorbed into the blood, the increase in the blood sugar being readily detected.

Stage 3. Some of the sugar is rapidly carried to all the tissues in the body, in which it undergoes a series of complex changes, but it will be sufficient if we concentrate on the final results.

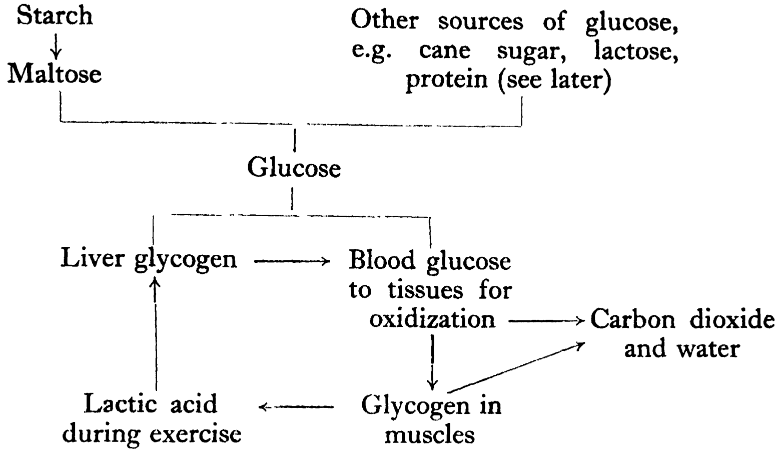
The flooding of the tissues with an increased amount of sugar is followed very rapidly by a rise in the oxidizative processes and especially an increased sugar utilization. This increase in the metabolism of sugar does not last long, even when absorption is still going on from the intestine.

Sugar absorbed from the intestine first passes by the portal circulation into the liver. The flare-up in metabolism just referred to is associated with the passage of some glucose straight through the liver to the muscles and other tissues. But simultaneously with this passage through the liver, sugar is being converted by the liver cells into glycogen, and held back in the liver itself.

Stage 4. This is the stage of storage and control. The rapid release of all the sugar absorbed would obviously be a wasteful process, since it would either lie dormant in the blood, and possibly pass out into the urine, or it would keep up a high rate of metabolism, with no other result than to produce heat to be radiated away. The excess sugar is changed into glycogen, which is readily stored in the liver and in the

muscles, as well as in other organs. Later as necessity arises this glycogen can be changed back into glucose, and released for oxidization.

Schematically represented the process is somewhat as follows:



Certain matters in this simplified scheme must be shortly referred to:

(*a*) Liver glycogen may be regarded as a store from which glucose is released as required. It is reserve carbohydrate.

(*b*) Glucose carried by the blood to the muscles is also changed to glycogen by the muscle-cells, and it is probable that it is used by the muscle as glycogen.

(*c*) During muscle contraction, as in exercise, muscle glycogen is broken down to lactic acid. Whereas liver glycogen is released from the liver as glucose, muscle glycogen is always released as lactic acid.

During muscular exercise lactic acid is liberated from muscle glycogen and a great increase of this acid is detectable in the blood. The fate of this lactic acid depends on circumstances; it is in part oxidized, in part changed back to muscle glycogen, in part converted to glycogen in the liver and partly lost in the urine. In each case, except the last, the lactic acid is not lost to the body; but becomes available again as either glycogen or energy.

(*d*) The final fate of the carbohydrate, taken in whatever form, is that it is oxidized away to carbon dioxide and water, with the liberation of a certain amount of energy.

Total Metabolism

From the quantitative point of view, total metabolism means the amount of heat produced by the body in a given time.

Heat is measured in calories.

A calorie is the amount of heat required to raise the temperature of a litre of water 1° C., i.e. 1¾ pints of water 1·8 F.

By various direct and indirect methods which we need not describe it is possible to measure the amount of heat produced by a man or an animal. When this is determined with the subject at rest, and after about fifteen hours without food, we speak of the heat production or metabolism as basal metabolism. In order to be able to compare different people in different conditions it is necessary to have some sort of standard, and the standard taken is the amount of heat produced per square metre of body surface per hour. We find the amount of heat produced per hour, and divide this by the surface area of the subject; the latter being calculated by means of a formula depending on the height and weight of the individual. The basal metabolism is different at different ages and for the different sexes. The following table gives average values for boys, men, and women.

	Age	*Basal Metabolism* (Calories per sq. metre per hour)
Boys	12–13	50
Men	20–50	40
Women	20–50	37

Thus the basal metabolism is higher in youth than in middle age, and is greater in the male than in the female. In old age the basal metabolism is less than in middle life.

When investigating the basal metabolism, it is usual to express the result as a percentage difference from the standard average values for the age and sex of the subject. So, if we say that the basal metabolism is +10% we mean that it is 10% above the average value associated with the age and sex of the particular individual under consideration. The range of variation which is found to include the normal is about 10% both ways, i.e. if a result is +10% or − 10% we still consider it normal. Values outside this range are regarded as abnormal.

Let us consider a normal man of about thirty years, height five feet eight inches, and weighing eleven stone. The surface area of such a man is 1·8 square metres (1 square metre is equal to 10·77 square feet). Then the basal metabolism of such a subject is $40 \times 1{\cdot}8$ calories per hour, i.e. 72 calories per hour. Therefore in one day he produces 1,728 calories. This is the amount of heat he produces basally, that is, without food and at rest. Work will, of course, increase the metabolism, and the source of the increase must either be his own tissues or his food. One can calculate a diet on the basis of the amount of work a man is to perform, but this is unnecessary normally, because the

organism regulates automatically (by means of appetite) the quantity of food necessary.

The amount of energy obtainable from a diet will depend not only on its quantity, but also on its make-up. The heat obtainable from a given food is called its *calorific value*.

1 gram (15·4 grains) of	protein	yields 4·3	calories.
1 "	fat	" 9·5	"
1 "	carbohydrate	" 4·2	"

Provided we know the amount of each of these food types in the diet eaten it is simple to calculate the heat value. Let us take, for example, ordinary white bread, containing of available energy-giving matter: 7·1% protein, 1·2% fat, and 52·3% starch. From this we calculate that the heat value of 1 lb. (453·6 grams) is about 1,190 calories. Beef steak contains 22·8% protein, and 19·4% fat, and no carbohydrate at all. From this we calculate that 1 lb. cooked beef steak gives about 1,290 calories of heat. Butter is 81% fat and only 1% protein; from which we find that 1 lb. butter yields 3,400 calories.

VIII—THE NERVOUS SYSTEM

THE nervous system is the master system of the body, and through it alone the body is put in touch with the outside world, and is enabled to adjust its movements in accordance with what is seen, heard, tasted, smelt, and touched. We are apt to think of the brain as the seat of our intelligence, and it is true that man is distinguished from his cousin, the ape, chiefly by his highly developed forebrain; but it is well to remember that this distinction of ours has been—geologically speaking—only recently acquired, and is still more easily thrown out of gear than the older, more primitive, and more firmly established elements of the nervous system.

ANATOMY

Those of us who have ever looked round a butcher's shop know roughly what our own brains look like. In colour the brain is white with grey patches; in substance it is soft and of the consistency of a blancmange. The brain, as we know, is strongly encased in that strong bony box, the skull, and the spinal cord in the flexible bony canal formed by the vertebral column. Nerves from the brain—the cranial nerves—issue from various openings in the skull, and go to the ear, the eye, the nose, the mouth, and the skin and muscles of the face. These nerves, situated at the head end of the body, the end that thrusts its way inquiringly into the world, are obviously of great importance. They are twelve in number. Three of them govern the movements of the eye, and one transmits to the brain the stimuli of light that fall upon the retina at the back of the eyeball. Of the other eight nerves, one subserves the sense of smell; one that of taste and sensation on the skin of the face, and governs the movements of the jaw; one controls the muscles of expression; one conveys sound-messages to the brain; another looks after the muscles of the tongue; another after those of the upper part of the gullet; another deals with certain muscles of the neck and shoulder; and, finally, there is the important nerve that first supplies the muscles of the palate, of the upper part of the gullet and of the vocal cords, and then continues, deep in the neck, to branch out to the lungs and the heart and, not content with this, ends by sending branches to the stomach and intestines.

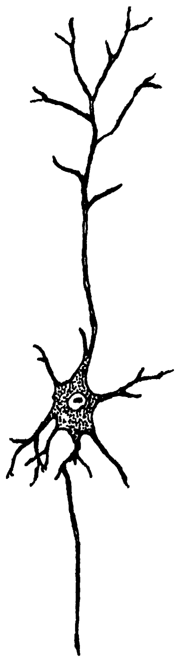
From the spinal cord nerves run out through the gaps between the

vertebrae to every nook and cranny of the body. Both the spinal cord and brain are covered with skins or membranes called the meninges (meningitis, as is explained elsewhere, is an inflammation of these membranes). The cord and the brain are bathed in the cerebro-spinal fluid, which acts as a buffer to protect them from jolts and jars.

Nerves are functionally of two kinds: motor nerves, which excite muscles to contract; and sensory nerves, which receive messages from the outside and inside world, and convey these messages to the spinal cord and brain.

THE NEURONE.

The nervous system consists of nerve-cells and nerve-fibres. These cells and fibres are grouped in an orderly way in the central nervous system, the brain and the spinal cord, and the fibres gather in bundles which, as we have already seen, reach the various parts of the body by passing through holes in the skull and between the vertebrae.


NERVE CELL

The neurone is the nervous unit, and the nervous system is but a collection of these units, held together in a supporting framework. The neurone consists of a nerve-cell; a nerve-fibre called the axon, which grows out of the cell and may be several feet long; and short branching fibres called dendrites, which also grow out from the cell. The dendrites come into contact with dendrites of adjacent cells. Nerve-fibres are for the most part enveloped by a fatty sheath; certain of them do not possess this sheath. The long fibre, the axon, may go, with axons from other cells, to a muscle or to a sense organ, or to any other organ of the body; or it may end in contact with another nerve-cell, the latter forming a sort of relay station. There is no anatomical continuity between one neurone and another; but there is physiological—that is, functional—continuity, and the area of junction between the axon of one cell and the dendrites of another (or between two sets of dendrites) is called a synapse. A nerve impulse may pass in both directions along an axon, but it only passes in one direction between one neurone and another, the synapse between the two acting, so to say, as a one-way valve. This ensures that nervous impulses pass in one direction only along a certain group of neurones. This one-way traffic-system for nervous impulses preserves the nervous system from chaos.

The largest nerve-fibres are something less than one-fiftieth of a

millimetre in thickness. The nature of the nerve impulse is unknown, but it is known that the passage of an impulse along a nerve is accompanied by electrical changes, and also by chemical changes. The velocity of a nerve impulse is in the region of one hundred and twenty metres a second.

Physiology

THE REFLEX.

A reflex may be defined as an automatic response of a muscle or a gland to an appropriate stimulus. The word 'automatic' implies an involuntary action beyond the control of what we call the will. An irritating article is blown into your eye and you automatically blink. A doctor taps your knee with a rubber hammer and your leg jerks forward. They are reflex actions which you do without thinking.

For the simplest kind of reflex involving the central nervous system to take place, there must be: (*a*) an organ for receiving the stimulus—the skin, the eye, the ear; (*b*) a sensory neurone to convey the stimulus from the receptor organ to the central nervous system; (*c*) a motor neurone to convey the message to (*d*) a muscle or gland to carry out the necessary and effective response: (*a*), (*b*), (*c*), and (*d*) constitute what is called the reflex arc. Just as the neurone is the anatomical unit of the nervous system so is the reflex the physiological unit. In the simplest reflex arc, as we have seen, there must be two neurones—a sensory and a motor.

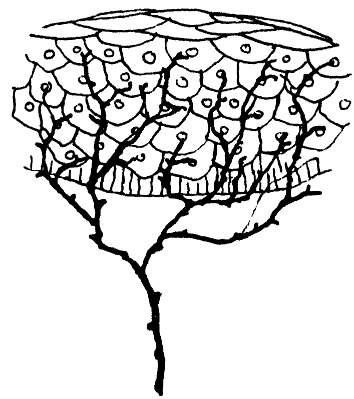
These are relatively simple reflexes, but experiments on animals and observation of human beings with diseased nervous systems show that there are a number of elaborate reflexes connected with the posture of the body. Standing upright and walking may be largely reflex in character, although the *intention* to stand or to walk is determined by the conscious will of persons carrying out these activities. The various reflexes that have been analysed by physiologists depend for their execution upon a complicated nervous pathway, and several neurones in the central nervous system are involved. It has even been suggested that the greater part, if not all, of the activities of a human being are reflex in character, and that, physiologically, human behaviour is just one reflex after another. This idea has been fostered by the work of the famous Russian physiologist, Pavlov. When food is placed in a dog's mouth saliva automatically flows—this is an automatic reflex action. If for a number of times food is presented to a dog simultaneously with the ringing of a bell Pavlov found that, subsequently, the ringing of the bell alone, without a meal being given, would make the dog salivate. This reaction has been, so to say, grafted on to the original reflex, and is called a conditioned reflex: the condition in this case being the previous association of bell-ringing with meal-times. By working

along these lines Pavlov has made many important physiological discoveries; and theorists have gone so far as to suggest that all human activity and behaviour is nothing but a complication of such conditioned reflexes. Life, according to this doctrine, is just a series of automatic responses to previous chance stimuli.

THE BASIS OF SENSATION.

Effective contact with the world depends upon an intact nervous system. This contact is maintained by an elaborate sensory apparatus, whose main function is to enable the body to make the muscular responses adequate to given circumstances at given moments. It makes it possible for you to jump on a bus just as it is passing you—not two minutes later.

The brain is essentially an organ for dealing with the sensory impressions that reach it: (*a*) from the outside world through the senses of sight, hearing, smell, taste, and touch; (*b*) from the muscles, tendons, and from the joint surfaces of bones; and (*c*) from the inside of the body—the heart, lungs, alimentary tract, etc. The reader is familiar with the obvious function of the eyes and the ears, but a closer analysis of other sensory elements will perhaps reveal to him a world of sensation he has not yet been aware of.



SENSORY NERVE-ORGAN IN SKIN

If we start with the skin it is evident from immediate experience that the sensory nerves that serve it convey sensations of touch, heat and cold, and pain to the brain. A famous neurologist, Sir Henry Head, once cut one of the sensory nerves supplying the skin of his hand. When the nerve 'grew again' it was found that the first sensations to return were those of pain, heat, and cold, and that at first only certain spots on the skin responded to these stimuli of pain and temperature, the intervening areas remaining anaesthetic. It was also observed that localization of the stimulus was inaccurate, and that fine degrees of temperature were not appreciated: that is to say, there was no distinction between warm and warmer—only between hot and cold. Only crude forms of pain were recognized, and reaction to them was excessive. Later on there was a return of a finer sensibility. Small changes of temperature could be distinguished. The ability to say what part of the skin was touched came back, together with discrimination of touch: that is, Sir Henry was able to recognize two

compass points held close together as two distinct points when applied to the skin. This experiment showed that there were two kinds of sensory nerves supplying the skin: one set concerned with conveying crude sensations of heat, cold, and pain; the other with finer differences of pain and temperature and touch. We find, too, that different parts of the brain are concerned with the coming-into-consciousness of these generally cruder and more delicate sensory elements.

In the skin special little sense organs or touch corpuscles are distributed for picking up touch stimuli; they are especially found round the roots of hairs. It has been discovered that certain spots or areas in the skin are particularly sensitive to heat—hot spots—and to cold—cold spots. The cold spots are concentrated mainly on the chest, abdomen, and inner sides of the arm. Touch spots are concentrated on the finger-tips, the tongue, the nose, and the lips—the 'feelers' of the body.

MUSCLE SENSE.

If you shut your eyes you can touch the tip of your nose with a finger. You know without looking what your legs and arms are doing. And, in fact, an important group of sensations arising in muscles, tendons, and ligaments inform the brain of what is happening in these structures. These sensations tell the brain of the position of a limb in space, of the extent of movements, of the degree of pressure on joint-surfaces, of the tension of ligaments and tendons, of the pressure on muscles. This 'deep sensibility,' as it is called, is something quite different from the superficial sensibility of the skin. Accurate movement depends upon accurate information. And all the complicated movements of walking, talking, running, all movements of skill, depend upon the integrity of the sensory nerves that convey the 'feelings' of the muscles, etc., to the brain. In locomotor ataxy these nerves are destroyed, so that the patient is unable to walk properly or to perform accurate movements; not because the muscles are weak, but because sensory communication between them and the brain has been destroyed.

SENSORY PATHS.

These sensations we have described travel, when translated into nerve impulses, along the sensory nerves which ramify throughout the body to the spinal cord. Long nerve-fibres thence pass them up the spinal cord to the brain, where the message is interpreted and the appropriate muscular responses are initiated. A part of the brain called the thalamus, which lies concealed beneath the cerebrum or forebrain, and from an evolutionary point of view is the more primitive and ancient structure, is the part where pain, heat, and cold are experienced in consciousness. Here also are probably the nerve-centres for emotional

reactions, such as rage, and laughter, and instinctive actions and behaviour. In this connection it is interesting to note that the 'head station' for the sympathetic nervous system probably lies just below the thalamus. The sympathetic nerves are of a more primitive kind than those we have been considering, and stimulation of them gives rise to the physical changes observed in states of fear and rage: increased blood-pressure, fast pulse, dilated pupils, hair standing on end, increased blood sugar, immobility of the intestines, and contraction of the skin blood-vessels. All this is a physical preparation for fight or for flight. In close anatomical relation with the thalamus is the ductless gland called the pituitary, which, like all the ductless glands, is intimately concerned with growth and sex and emotional development. The ductless glands (acting by the chemical substances they produce), the sympathetic nervous system, and the thalamus are the three mechanisms which underlie primitive and instinctive reactions.

THE CEREBRAL CORTEX.

This is the part of the brain which is more highly developed in man than in other animals. Two lozenge-shaped masses either side of the mid-line extend from the forehead to the back of the skull, and are called the cerebral hemispheres. The cerebral cortex, or grey matter, consisting of layers of nerve-cells, is on the surface of these hemispheres, and tracts of nerve-fibres link these cells up with other parts of the brain and with the spinal cord. The cerebral cortex is like a telephone exchange. It receives messages from all parts of the world of the human being, interprets them, and puts the caller into the right contacts. One part of the brain deals with the sound messages from the ear, another with the visual messages from the eye, another with taste and smell messages. It has to receive and interpret all the sensory impulses coming from the skin, the muscles, the joints, and the internal organs. The sensory part of the cortex is discriminative. Here are appreciated differences in intensity—between warm and warmer, soft and hard, smooth and rough; spatial relations—the localization of touch, the extent and direction of displacement of limbs; similarity and difference—size, weight, form, texture of objects. Another part of the cortex governs the highly complex functions of speech: the word is heard, is read, is spoken, and is written. Someone dictates a sentence, the sounds enter the ear and the impulses set up travel along the auditory nerve to the brain, a cerebral conjuring trick takes place, and the writer correctly writes down the sentence on paper—the brain instructing the hand what to do. These complicated activities can only be performed if the nerve-cells and nerve-fibres in the brain are intact.

An important function of the cortex is to control or inhibit lower

nerve-centres of the brain. For example, if in disease the cortex is cut off from the thalamus (an earlier and more primitive structure) the patient will laugh and cry with great facility for no apparent reason at all.

The cerebral cortex does not just sit and think. The mass of sensory impressions that reach it have to be translated into action, and in front of the main sensation-receiving stations is a large area of nerve-cells whose axons pass down into the brain-stem (joining the spinal cord with the cerebrum) and the spinal cord. These cells initiate voluntary movement: their axons end up in the spinal cord near the nerve-cells whose axons pass out of the cord between the vertebrae to end in the muscles of the limbs.

We make a distinction between the voluntary movements of the muscles of the limbs and of the body, and the involuntary movements of the muscles of the internal organs—the stomach, intestines, bladder, heart, lungs, and so on. The voluntary muscles, which are under the control of the will, are supplied by one set of nerves, which we have so far been mainly considering; and the involuntary by another set, the sympathetic nerves and the autonomic nerves—the chief autonomic nerve is the tenth of the nerves leaving the brain. But it is important to realize that one is not conscious of the contraction of the voluntary muscles or of 'willing' *this* muscle to do *that* movement, but of the displacement of joints and of movements at joint-surfaces. You are aware of your knees bending or of your arm stretched out behind you, but not of the muscular movements that effect these attitudes.

BALANCING MECHANISMS.

Situated close to the organ of hearing (which lies deep to the outer ear) are three small semicircular canals placed in three different planes at right angles to each other. These canals communicate with each other and with two small chambers called the saccule and the utricle. Projecting into the canals are fine stiff hairs, and the canals themselves are filled with lymph. When the head moves the lymph in the canals moves also, and exerts pressure on the hairs. The bending of the hairs stimulates the nerve-fibres in close contact with them, and the nerve impulses thus set up travel to various parts of the brain, giving the brain information about the position of the head. In the saccule and utricle are minute 'stones' or calcareous particles. When the position of the head is altered these little stones stimulate hair cells; this stimulation also is handed on to nerve-fibres, which carry information to the brain as to the altered position. The semicircular canals and the saccule and utricle also subserve reflex mechanisms for maintaining the head in an upright position, and for the adjustment of the position of the body in relation to that of the head in space.

THE CEREBELLUM.

The nerves from this balancing mechanism have important communications with the cerebral hemispheres, with nerve-centres controlling the movements of the eyes, and with the cerebellum. The cerebellum is a mass of nerve-tissue (in shape rather like a wart) situated behind the cerebral hemispheres and attached by bands of nerve-fibres which enter the brain-stem. The functions of the cerebellum are not very exactly known, but it seems clear that it influences 'muscle-tone.' Space does not permit a discussion of this important question of tone. Muscle-tone is a reflex contraction of muscle. It is a taking-in of the slack, a continued slight tension. This tone imparts the firmness to muscle which is always present even when the muscle is not executing a movement. Tone enables posture and position to be maintained: in its absence we should go 'all of a heap.' It is a reflex activity which depends upon sensory stimuli from the muscles themselves, and, to a less extent, from the eyes and the balancing mechanism in the ear, acting upon various centres of nerve-cells in the spinal cord and the brain-stem.

The cerebellum also appears to exercise some guiding control over the cerebral hemispheres in the carrying out of voluntary movements; for in disease of the cerebellum there is considerable disturbance of voluntary movement—a clumsiness and lack of co-ordination of muscles—and of balancing power.

THE INVOLUNTARY OR AUTONOMIC NERVOUS SYSTEM.

Brief reference has already been made to sympathetic and autonomic nerves. These names are rather confusing, but this group of nerve-cells and fibres (neurones) is concerned with involuntary muscle and the involuntary secretion of glands. Involuntary muscle is present in the heart, stomach, and intestines, lungs, blood-vessels, bladder, etc., and is beyond the control of the will. The activity of these organs is automatically regulated. It would be dangerous for them to come under the tyranny of the will, for they must work consistently and constantly; although there is no doubt that their efficient working is upset by emotional disturbances. These nerves are divided into two main groups, whose action is mutually antagonistic on the organs which they both supply. For example, the sympathetic nerves quicken the rate of the heart while the vagus nerve (an autonomic nerve) slows it down. The sympathetic nerves immobilize the muscles of the stomach and intestines while the vagus nerve causes them to contract. It has already been pointed out that the sympathetic nerves, when stimulated, produce the physical changes of rage and fear.

This involuntary nervous system has an important and essential

part to play in the control of blood-pressure and the heart-beat, of respiration, of movements of the alimentary tract and of digestion. In connection with these functions various important reflex centres exist in the brain-stem.

Summary

In this brief outline of the nervous system, condensation has been inevitable. It is important, however, to grasp the fact that the nervous system is not a collection of 'centres,' each looking after its own concerns, but is an integrating and co-ordinating mechanism whereby all the sensory impressions impinging on the body from within and from without are turned to harmonious action for the benefit of the body. No mention has here been made of the brain as an organ of mind: we have kept to known physiological facts.

IX—THE MIND

It has long been assumed that the human body is a kind of self-regulating machine. It is only just beginning to be suspected that the mind is just as much a machine as is the body; in the sense that it is a part of the ordinary world in which everything has a cause. The happenings which go on in the mind are such things as thoughts, feelings, and wishes: of these we have immediate knowledge in so far as they are our own; other people's mental processes are inferred by us from their behaviour. Thus the mind can either be studied by watching our own thought-processes (this is known as introspection), or it can be studied by watching the behaviour of other people. These two ways of looking at the mind produce somewhat different pictures, but it is generally believed that the mechanism which we study is the same in both cases. If we look at a motor car from the outside, a different impression is obtained from that made if we are seated within the car, and examining the controls: the essential mechanism, however, is the same.

Three Mental Processes

It is customary to divide the activity of the mind into three components—thinking, feeling, and willing. By the word 'willing' we mean the desires, impulses, and wishes which cause us to act. These mental processes are not entirely separate, but the division is a convenient one. The mind can be regarded as a sort of controlling agency of the body: the more highly organized the animal body the more complex the mind will have to be. In the lower forms of life we discover merely simple reactions, such as moving away from a noxious object in the vicinity. Some plants and lower animals are so simply co-ordinated that they can be cut in pieces and yet each segment will grow and live as an individual. The mind necessary for such forms of life must be a very simple one, and cannot have the same centralized unitary nature as our own. The development of mind in the course of evolution is coincident with the development of the nervous system and, as the animal becomes more and more of a unit, the nervous system is found to be correspondingly more complex. This system reaches its highest development in man, and its centre is the brain, which is closely associated with the co-ordinating process which we term the mind.

The rules by which the mind works and the causes of thoughts and feelings are beginning to be understood, but, at present, there are big gaps in our knowledge. At the same time these gaps are mainly concerned with the details, and the general outlines of the mental processes can be described. Of the three types of processes which we mentioned earlier, the most important is that concerned with wishing and with acting in accordance with these desires. The desires are the driving force of the machine. Without these fundamental desires there would probably be no thinking and no feeling. All desires and wishes spring ultimately from inherent tendencies or modes of behaviour known as instincts. We will therefore first of all consider the nature of these inherent tendencies.

Man is an animal, and he shares with other animals two fundamental necessities. These necessities are to safeguard his own existence (by obtaining adequate food and keeping off enemies) and to perpetuate his kind in the form of offspring. There are also subsidiary necessities, such as the need for acquisition and storage of food and the need for suitable care of the offspring while they are unable to care for themselves. Squirrels store nuts so as to have food for the winter, birds gather sticks and build nests in which to lay their eggs, and the higher animals feed and guard their young for months and even years. The instincts are developed in order to meet all these needs. If we consider the first group of impulses—the instincts of self-preservation, as they have been called—we shall find they involve hunger as the most important item. This desire to assimilate food is closely related to destructive and aggressive impulses: it may be necessary for the animal to hunt, to fight, and to destroy in order to obtain its food. The impulse of self-assertiveness is probably derived from the same source.

An animal will not survive unless its aggressive impulses are strong enough to enable it to obtain what is necessary and to defend itself from its enemies. The impulses which are directed towards the preservation of the race of which the individual is a member are known as the sexual instincts. It is obviously just as important to a race of animals for these instincts to be strong as for those of self-preservation—possibly much more important. While the hunger group of instincts are associated with aggressiveness and self-assertion, the sexual instincts are of a more altruistic character. They are directed towards the preservation of persons other than the self, and the actions which they promote are characterized by feelings of love and tenderness towards other persons. To some extent these two main groups of instincts conflict with one another in the individual, but, normally, a state of equilibrium is obtained. When a male animal fights with its rival for the possession of a female the aggressive impulses and the sexual impulses are both aroused and work together harmoniously for the same end. A similarly

effective mixture of impulses occurs when a lioness defends her cubs. This capacity of impulses of different kinds to mix with one another, giving rise to an effective resultant activity, is a fundamental characteristic of the mind. As we conduct our ordinary lives we are not usually aware of the violent forces inside us. This is because, in the course of evolution and individual development, the conflicting impulses have been so perfectly balanced that we are not conscious of them. When we say that impulses are repressed, this is what we mean: thus, repression is a perfectly normal and necessary process. It is probable that the race-preservative impulses must predominate in order to produce a civilized community, and many psychologists hold that the main motive power of all our social life depends upon them. Normally, our aggressive impulses are largely repressed, and we are enabled to entertain friendly feelings even for our enemies.

When we come to the consideration of the other two great divisions of the mind, feeling and thinking, we can detect the underlying instinctive forces, though sometimes it is not easy to perceive exactly of what type they are. With regard to feeling, the most important 'modes,' as they are termed, are pleasure and pain. Pleasure and pain are closely related to the instinctive forces and, roughly speaking, while pleasure is associated with the satisfaction of a desire, pain is associated with events which are antagonistic to its fulfilment.

In the ordinary sensations of touch, vision, taste, and so on, we may not often detect the impulses which are brought into play, and so enable us to appreciate the meaning of the sensations. This is again due to the fact that we are highly complicated organisms. Similarly, with regard to thinking, which must include imagining and day-dreaming, as well as consecutive trains of thought, the desires which are causing us to make certain efforts, or to be presented with this or that idea, are not immediately apparent. Our dreams at night are brought about, to a large extent, by impulses which have been repressed and have not been satisfied during the day. But even in dreams the true wishes which lie behind them are not discernible without painstaking analysis. In fact, we hardly ever know what our real motives are. The forces which drive us are so poised that we can only think clearly when we are unaware of the reason why we think. Under the influence of over-mastering passion we do not behave in the most logical manner. As with our social activities, so with our thoughts and our constructive abilities, it is probably necessary that the instincts of race-preservation should have a slight preponderance over those of self-interest. In the words of St. Paul: 'If I speak with the tongues of men and of angels, but have not love, I am become sounding brass or a clanging cymbal.' We shall see, when we come to the discussion of mental abnormality how very important this principle is.

THE WORKING OF THE MIND

We will now turn to the question of how the mind is kept in a healthy state. From what has been said already, we know that a person's actions are determined by basic impulses of the crude animal type which are combined together and adjusted to produce delicate and fine reactions. This way of harnessing the instincts has been termed 'sublimation,' and our ordinary everyday activities, or what we call our work, are instances of sublimation. It must be remembered that the instincts do not lose their force in this proceeding, it is only that they are properly harmonized. It is just as serious a matter for a man, who is accustomed to a certain type of work, suddenly to have to change it as it is for him to go hungry. Psychologists have noticed, even, that certain people who are accustomed to work in an office all the week and who, during that time, are efficient and cheerful, become sullen and bad-tempered for no apparent reason on Sundays. On the other hand, it is equally important that time should be available for the recuperation of energy in order to obviate fatigue and boredom. Recently a great deal of experimental work has been done on the question of how the mental apparatus works best. It appears that, in some types of occupation, a maximum efficiency is obtained and, after that, there is a slow decline unless some new factor, adding interest, enters into the work. There is a curious relationship between fatigue and boredom. When a person is presented with a new problem or a new technique which he has to learn, first of all there is an improvement in his ability, and this improvement may even accelerate at the beginning. Soon, however, the rate of improvement begins to decrease and, finally, a level is obtained beyond which the individual does not seem able to advance. Then, after a time, boredom may set in, and the results will deteriorate. If the problem is changed, however, the same type of improvement will start all over again. It has been shown by physiologists that neither the nerves nor the muscles themselves are at all easily fatigued, so that deterioration, or lack of improvement, in work of a monotonous character is usually not due to fatigue at all, but to boredom. That is to say, the direction of the basic impulses begins to wander and they are diverted into other channels. Different people vary very much in what constitutes monotony for them. To some people the repetition of the same type of behaviour may be an obsession, but this is an abnormality. Actually a periodic change in occupation is essential for the highest efficiency. This is why we have Sundays and other holidays; and to neglect opportunities for obtaining recreation or changes in surroundings will, sooner or later, lead to boredom in work.

What has been said regarding work applies also to play, and perhaps it is easier to understand in this connection. In games the primary

impulses are less hidden than in many other social activities. The game, in fact, is the earliest form of sublimation. In its primitive form it occurs naturally in the behaviour of the young of all the higher animals. The balance of different types of impulse, which is obtained in an occupation like football, is comparatively easy to detect. Here the player, for the time being, loves his own side and hates the opponents. The hatred, however, is not allowed to overstep well-defined boundaries and, in order to obtain the commendation of the spectators which is necessary to his own self-esteem, the player obeys these rules of the game. In this way his pride and his aggressive impulses are balanced against his friendly and altruistic feelings towards the members of his own side, with whom he is able to indulge in an obedient admiration for the captain. All these instinctive desires are satisfied at the same time by the game. Perhaps one of the reasons for the popularity of games lies in the very fact that they are a much less complex method of reacting to the fundamental driving forces of the mind than such things as office, factory, or house, work. Recreation, therefore, is just as much a method of reacting to fundamental impulses as is everyday work. The staleness of which players and athletes complain during a prolonged period of training is again usually an instance of boredom and not of fatigue, and it is an indication that a temporary change of occupation is needed.

The Development of the Mind

We have not yet touched on the question of how the mind develops in the individual. The newborn baby has practically no mind: it only has the primitive instinct of self-preservation, and this causes it to make sucking movements when placed at its mother's breast, and to cry if it is hungry. During the course of its growth to adult life it will acquire modes of behaviour: its instincts, as well as the rest of its mental apparatus, have to be developed step by step. How does this development take place? The psychologists a hundred years or more ago had already enunciated what was known as the law of association. This law of the mind means, roughly, that any two happenings which are perceived or felt at the same time, or any two thoughts which arise simultaneously, become afterwards associated with one another so that the memory of one recalls the memory of the other. James Mill and other English writers of the time were able to give a fairly plausible description of the development of mental activities such as language, the use of numbers, and so on, by using this principle as a working rule. More recently, scientists have carried out experimental investigations the results of which are much more convincing than the theorizing of the older psychologists. As we saw, the Russian physiologist, Pavlov, has

shown that dogs learn quite automatically to associate experiences which occur simultaneously. In Germany, Koffka has made similar experiments on the methods of learning of monkeys; and in America, Watson showed that young children and even adults form their associations in the same way. The laws of association, or the laws of conditioned responses, as they are known to the experimentalists, are now well established, and this accounts for the process of learning which the individual undergoes in the course of development from the infant to the adult.

We may look on the laws as governing either thought or behaviour, but, from whichever point of view we look at them, one striking fact emerges. The psychologists noticed that associations were most readily formed when the mind was in a state of alertness or attention. Pavlov found that his dogs would only learn when they were under the influence of hunger and also in a friendly mood. This means that the driving force of some instinct is necessary in order that learning shall take place. In fact, the whole development of mind is moulded so as to be of service in the satisfaction of the essential animal instincts. In the case of the child the development of its instincts is very complex. In the earliest stages its dependence upon its parents, particularly upon the mother, is complete; and the importance of the parents in determining the way in which the child develops cannot be overrated. In studying the mental illnesses, the Viennese professor, Freud, found that he could trace most of the important associations connected with these disturbances to very early life. He originally suggested that nearly the whole basis of mental development was laid down before the age of five years: subsequently the ages between one and three years have been regarded as the most important. It is quite reasonable to suppose that in these early years, when the mind is growing most rapidly, the most important types of reaction are laid down. These early mental structures will last the individual the whole of his life, and will form the outline pattern into which subsequent associations will be fitted. It is difficult for an adult to imagine the awe with which a child views its parents and other grown-up people with whom it comes into contact. These persons it regards as infallible, and it feels instinctively that they have its interests at heart. A sudden change of attitude on the part of a person who is in a position of authority over a young child, or inconsistencies in behaviour, may lead to conflicts in the child's mental development, and cause serious disturbances later on. Unfortunately we do not yet know sufficient about the formation of the mind in young children to be certain what types of action on the part of parents are always best from this point of view. Many of the actions of parents, such as punishments, for example, which may harm the children are done with the best intentions. Since the parents are unaware of their

own fundamental impulses, the best-motivated actions may even be the most harmful. It is difficult to realize how deeply a child feels when it is put into disgrace or punished. On the other hand, certain kinds of discipline may be helpful to the child in after life, and opinions differ widely as to the best methods of moral education. We can, however, be certain of some general principles.

The most important of these is that the child should be treated fairly, and without gross inconsistency. It should not be praised one day for doing something for which it is punished the next day. Perhaps we can draw an analogy with the nutrition which is necessary for the proper growth of the body; the growing mind also needs nourishment. While there are essentials known as vitamins in the nourishment of the growing child, so there are essentials in the mental sphere. The child is very dependent upon adults, and it requires to be assured by the way in which they behave that the adults are willing to supply the love and interest which it needs. The child, brought up, from early years, in surroundings where adults are antagonistic, develops a one-sided or anti-social character. Its mind has been starved of the essentials, even if it has been crammed with learning. A great deal of the growth of the mind takes place simply by copying the reactions of other people, and the child unconsciously copies the actions and imbibes the outlook of people with whom it is brought up. Thus, a child brought up by inconsiderate or cruel people may copy them and develop the same mentality. This pliability of young children is sometimes known as suggestibility. While children are normally suggestible, suggestion also plays its part with adults. An adult who is unduly receptive in this way is incompletely developed. We shall see, when we come to the study of mental disorders, that incomplete development is very common, and is one of the most potent causes of later troubles. It therefore behoves the parents to encourage children to think for themselves rather than to obey implicitly and, as far as possible, to give reasons rather than orders. Children should not, for example, be stuffed up with lies about sexual matters. Such behaviour tends to inhibit the proper development of the powers of thinking and feeling.

While these principles are useful in procuring the mental health of children, and for preventing troubles later on, the most valuable test of mental health in a child is whether or not it is happy. A child who is happy and seems to be at ease with its surroundings cannot be mentally ill. In view of the difficulty of curing mental disorders in later life the careful attention to the needs of the minds of young children cannot be too strongly urged.

X—REPRODUCTION

LIFE is a cycle, and birth is but the commencement of a journey which continues through youth, maturity, and old age, to end in death. To ensure the continuance of the species, Nature is most ingenious and prolific in her reproductive efforts. The lowest forms of life consist of but one single cell, and reproduction is effected by binary fission. The cell merely divides into two parts, which in turn increase in size and, under favourable circumstances, themselves divide in a similar manner some twenty minutes later. A simple calculation shows that if this process proceeded unchecked a single bacterium would, within the space of twenty-four hours, be the parent of a billion daughter bacteria; so that, if other factors did not intervene, it is evident that the whole world would soon be filled with living germs. In point of fact, lack of available food and the toxins extruded by the dead bacteria serve to control their numbers. The laws of over-production and the struggle for existence, first enunciated by Malthus and Darwin, apply to all living things. It has been estimated, for instance, that if all the offspring of a single pair of thrushes survived and mated there would within twenty years be so many billions of thrushes in the world that there would not be room enough on the earth's surface to contain them, even if they stood in rows touching each other. Similarly, if the normal reproduction of herrings proceeded unchecked, then within five years the sea would be a solid block of this prolific fish.

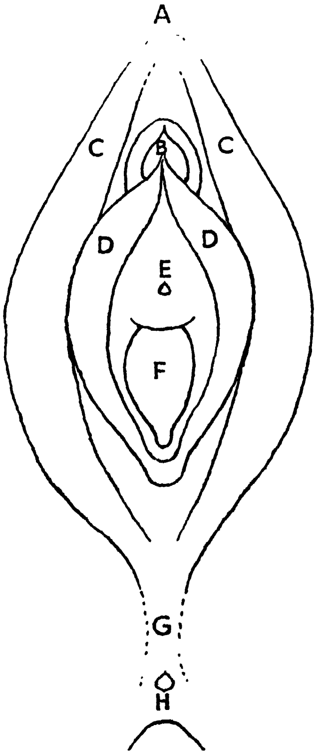


DIAGRAM OF THE FEMALE EXTERNAL GENITAL ORGANS

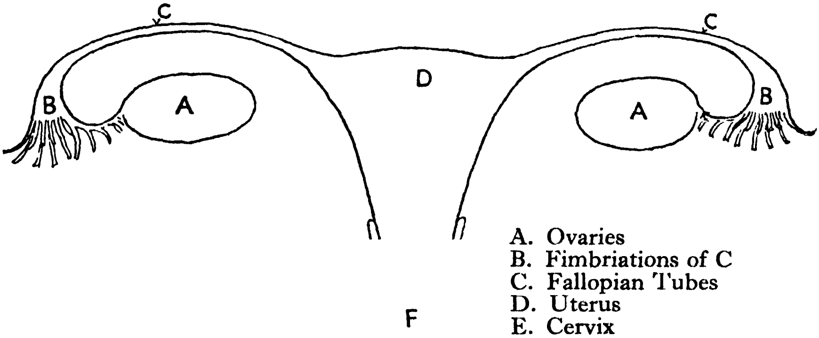
A. Mons Veneris; B. Clitoris; C. Labia Majora; D. Labia Minora; E. Urethral Orifice; F. Vaginal Orifice; G. Perineum; H. Anus

The single cell, of which the lowliest forms of life consist, performs all the functions necessary to life. Man, at the other end of the scale, is made up of thousands of millions of cells. His brain alone contains

some twelve thousand million cells, while his red blood corpuscles, which represent less than one-twentieth of his body weight, would, if placed touching each other in a line, stretch right round the coast of Great Britain. Nevertheless, every living thing develops from a single cell, and to this law there is no exception.

Sexual Reproduction

The lowest forms of life reproduce themselves asexually, but very early as we ascend the scale of the vegetable, as of the animal, world, sexual reproduction becomes the rule. The essence of sexual repro-



A. Ovaries
B. Fimbriations of C
C. Fallopian Tubes
D. Uterus
E. Cervix
F. Vagina

DIAGRAM OF THE FEMALE INTERNAL GENITAL ORGANS

duction is that the cell from which the animal or plant develops is enriched by the transference of material from another specialized cell, a process termed fertilization. The fertilized ovum then keeps on dividing, until the particular form of life is mature. In between the stage of simple division and that of sexual reproduction, an intermediate process, a form of budding, may be observed. Two cells approach each other, and material from the one buds into the other. This, although strictly asexual, is essentially an example of the principle which the sexual process is designed to perfect. Some simple forms of life, such as the parasite which causes malarial fever, have two ways of reproducing themselves, one sexual and the other asexual; but with them asexual reproduction cannot continue indefinitely. Fertilization, or the transference of material from the male to the female, must occur at intervals, failing which the parasites die. It is impossible to offer a satisfactory explanation of why fertilization is essential to the reproduction of higher organisms, but the fact is that neither life nor reproduction can be fully explained in terms of physics or chemistry.

It has been stated that, just as one bacterium can give rise to a prodigious number of daughter bacteria, the fertilized ovum from which man develops similarly gives rise to thousands of millions of cells. Except, however, from the numerical standpoint, the processes are entirely distinct. The bacteria are all identical, whereas the cells into which the fertilized ovum divides consist of many and varied types. If, for instance, a minute portion of the eye of the chick embryo be

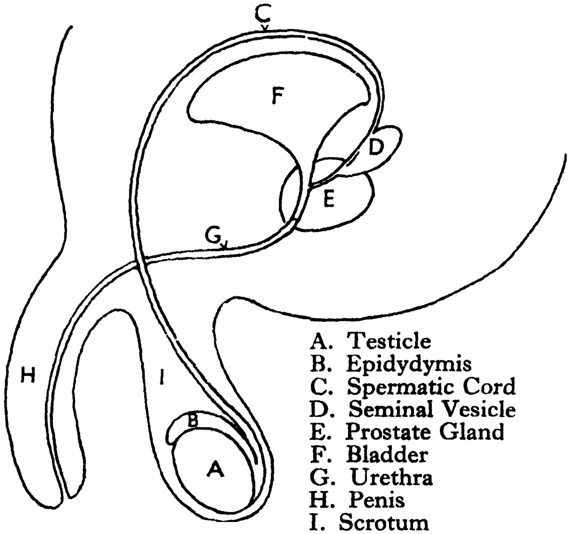


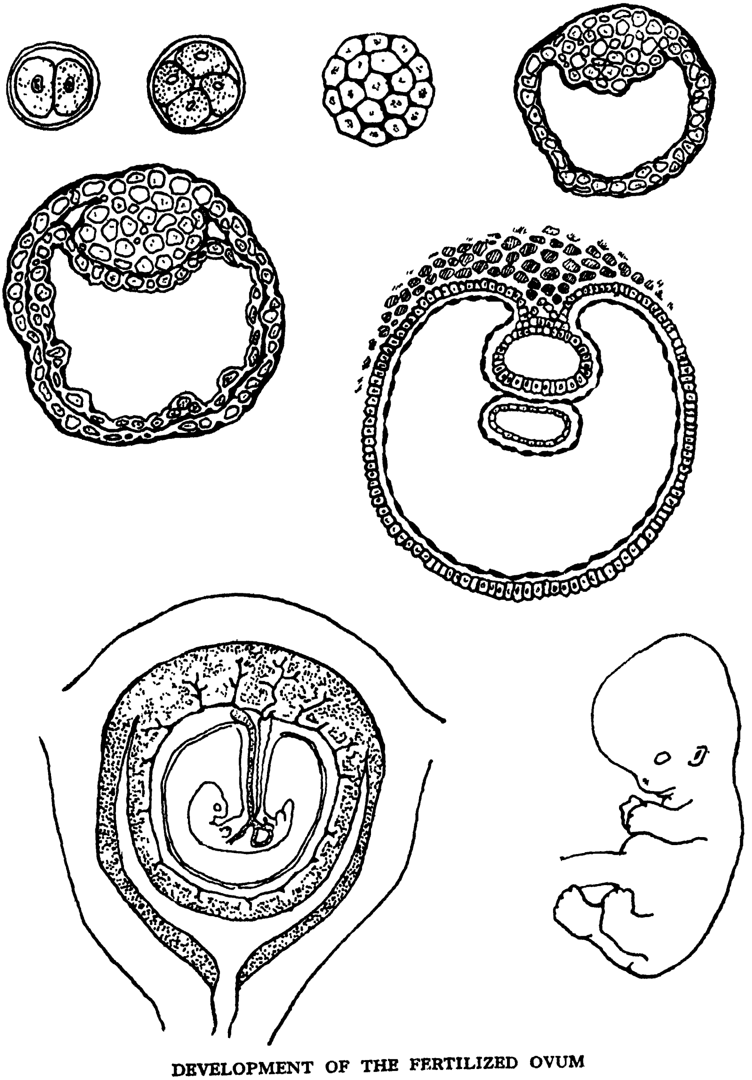
DIAGRAM OF THE MALE GENITAL ORGANS

removed from the egg with a fine needle and placed on a suitable medium, something resembling an eye will develop. This process, termed tissue culture, shows that in the early stages of division certain cells are formed which have the inherent power to develop along certain lines, some into brain, some into muscle, some into bone, and so on; and that this power is retained to a marked degree even when they are removed from the rest of the embryo.

CELLULAR DIVISION.

Further, the division of each cell into two parts is a very elaborate and profoundly fascinating process. A cell consists of protoplasm, or living matter, which contains a nucleus and a nucleolus, two small collections of highly specialized protoplasm which govern and control the cell. The nucleus contains several 'threads' or chromosomes, the number of which for each species is constant in every cell. These chromosomes are of the most profound significance, and will be referred to later; but here the thing to note is that each of the two resultant

cells is furnished with an exactly equal amount of chromosome material. It is possible by the aid of powerful optical instruments to watch this



DEVELOPMENT OF THE FERTILIZED OVUM

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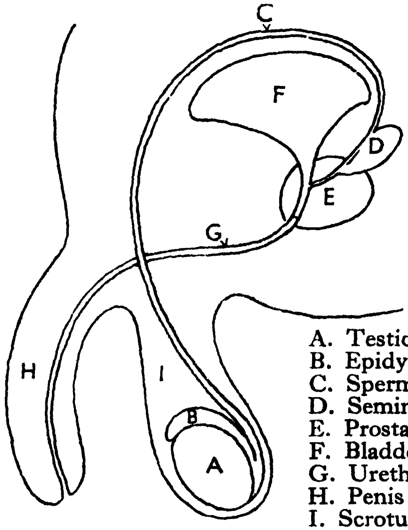

A. Testicle
B. Epidydymis
C. Spermatic Cord
D. Seminal Vesicle
E. Prostate Gland
F. Bladder
G. Urethra
H. Penis
I. Scrotum

DIAGRAM OF THE MALE GENITAL ORGANS

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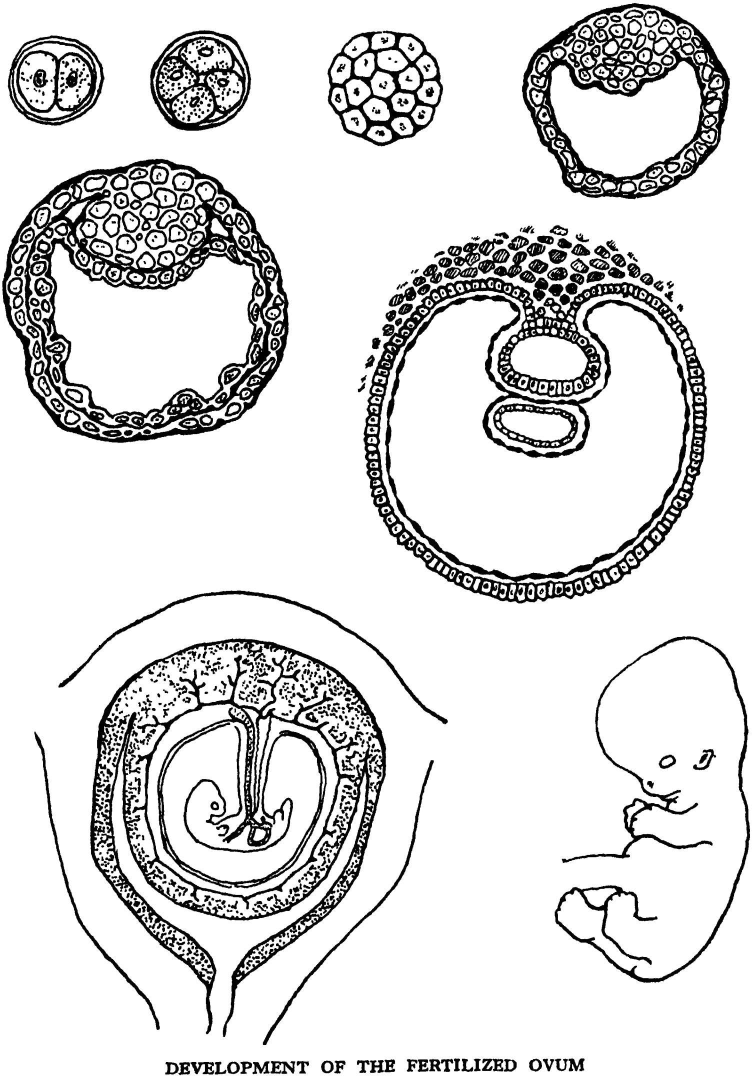


DEVELOPMENT OF THE FERTILIZED OVUM

division taking place, and it is reminiscent of a volcano in action. Cinematograph films have been taken which portray the mysteries of cell division; and even the hardened scientist is usually thrilled when he is first privileged to see this process so instinct with life and energy,

and realizes that the dividing cell was derived from a cell which could trace its parentage back perhaps for millions of years.

THE CHROMOSOMES.

It has been asserted that the chromosomes in the nucleus of the fertilized ovum are of the most profound significance. Whether a particular ovum develops into a chick, a rat, a horse, a cow, a Chinese, or an Englishman, is largely determined by the chromosomes. On them depend not only the shape and configuration of the plant or animal, but also the character. The hereditary characteristics, good and bad, and some of the physical defects, of all the men and women living in England to-day were at one time 'contained' in chromosomes, the whole of which could have been placed with ease into an ordinary matchbox.

The egg of a hen or other bird contains in its yolk a minute ovum, which can be seen by means of a suitable lens. Both the yolk and the white of the egg are designed merely to provide food for the growing embryo. The shell is porous, and through it the developing chick 'breathes.' All birds and some reptiles lay eggs which are hatched either by the warmth of the body or the heat of the sun, but in no case will development take place unless the egg was fertilized before it was laid. In mammals such as the horse and dog, and including man, the ovum, which is of the same order of size as that of the chicken, is not provided with a large amount of nourishment, but obtains its food supply from the mother's blood. Development occurs in the uterus or womb. The mother's blood does not pass directly into the foetus, but the requisite nourishment is filtered through a membrane folded into hundreds of thousands of folds, and contained in the placenta or after-birth.

REPRODUCTION IN MAN.

It is now possible to consider the main facts concerning reproduction as it occurs in man. The important cells are the ovum and the spermatozoon. The ova are contained in two organs called ovaries, which are situated one on either side of the pelvis. In size and shape these roughly resemble a large brazil-nut. When a female child is born each of her minute ovaries contains about a hundred thousand ova, but by the time she reaches puberty this number has considerably decreased. From then on, at least one ovum ripens each month, and escapes from the ovary into one of the two fallopian tubes which lead into the uterus. The neck of the womb passes out into the top of the vagina, or front passage. It follows that the inside of the uterus is in direct communication both with the peritoneal cavity and with the outside of the

body, a very important fact. If the ovum becomes fertilized it embeds itself in the lining of the uterus, establishes its own blood supply through the placenta, and develops until the child is ready to be born.

The spermatozoon, or male reproductive cell, develops in the testes, of which there are two in the purse-like structure which hangs between the thighs, known as the scrotum. During coitus or sexual intercourse millions of spermatozoa are ejected into the vagina. They possess tails by which they travel into the neck of the womb and up the uterus to meet the ovum in one of the fallopian tubes. Only one spermatozoon pierces and enters the ovum. The fertilized ovum possesses the requisite number of chromosomes, half of which derive from the male and half from the female cell. It follows from this account that sex-appeal and sexual excitement have as their biological purpose the facilitating of the meeting of the spermatazoon with the ovum. It also follows that, whereas with the male the function of reproduction would appear to be something almost extraneous to his ordinary activities, woman is peculiarly constructed to conceive, bear, and suckle children.

The testes and the ovaries, in addition to their germ-cell activities, elaborate 'internal secretions' which are largely responsible for determining the secondary male and female characteristics. Each man, however, contains a certain amount of the feminine, and each woman a certain amount of the masculine in their make-up; whilst, in extreme cases, the man may be very 'effeminate,' and the woman exceedingly 'masculine' in type. In any given society, it may be assumed that usually the most feminine women, or those biologically most successful, will be selected for marriage.

PART TWO

EVERYMAN IN HEALTH

I—HEALTH AND DISEASE

ABSTRACTLY we may look upon health as a condition of harmonic fluctuation between our several parts, bodily and mental, as well as a harmony between ourselves as a whole and the outside world, including our fellow human beings. This, as has been said, is not a static condition, but one of constant vibration and adjustment. There is a normal, to which all the functions of a healthy man tend to approximate. At every moment the pendulum swings a little, now to the right and now to the left of the centre of its arc. But the divagations are never great, and readjustment is prompt. When, through external circumstance or faulty structure, aberrancy from the normal is wider than our recuperative faculties can rectify, we have disease. The fundamental problem of the medical art consists in the recognition of the conditions or faults responsible for such aberrancy, and the discovery of the conditions most favourable for the operation of the natural healing powers of the body. Sometimes a chemical or physical defect can be made good; sometimes a hostile force can be warded off or destroyed. Sometimes the automatic defensive mechanisms of the body can actually be supplemented; but all the time the aim of wise therapy is to restore a working balance, a sustainable harmony, even if this has to be of a kind somewhat different from that which previously obtained.

But an adequate concept of health includes more than the existence of an almost passive harmony. It implies the making the most of ourselves and realizing the best of which we are capable. The word itself signifies wholeness or haleness, and is probably synonymous with holiness. The concept of health which has become current in recent times is far too narrow. With the progress of the medical art disease has assumed increasing importance in human thought; and by disease has commonly been meant the existence of one or the other of those recognizable syndromes, or collections, of unpleasant symptoms to which, by reason of their recurrent similarity, specific names have been applied. Health has come to mean, in common talk, an absence of each and all of these several forms of disorder. This negative attitude to health is numbing to vitality. The conception is a passive one; the reality is an active one. The truly healthy man is courageous, not one in hiding, even though his skin be still intact. He looks hopefully forward, not timorously behind him; he is resilient, not

static; he is enthusiastic, not merely enduring; his body and mind are one, collaborators in an enterprise pleasurably exciting. Smooth sailing is not expected; and, when necessary, the decks can be cleared for action in a fraction of time. Fear takes its proper emergency station; hope, interest, and eagerness inform his acts and thoughts; prudence is suffused with faith; the body is cared for by the mind, and the mind is tended by the body.

This general picture of health and of the healthy man must not be taken to imply the non-existence of specific dangers and specific enemies, calling for methods of defence and resistance equally specific. To some extent man, in common with other animals, is equipped with protective weapons, operative without the intervention of his intellect and his conscious will; but our species would appear to have an endowment shared but in small degree, if at all, by the rest of the animal creation. We have the strange power of contemplating and analysing the circumstances that environ us, and of devising means differing from a thing 'naturally' existing whereby these circumstances may be modified or countered to our advantage. Man has invented houses and clothing and fires; he has invented cooking; he has created instruments whereby he can see the hitherto unseen, and an apparatus enabling him to convert into audible sound ethereal vibrations of the existence of which our ancestors had no suspicion.

The old view that the entire universe, or at any rate that this world and all its creatures and component parts were created to satisfy the needs and tastes of man, to which so many of them do, indeed, minister, has largely given place to a converse conception. Anatomists and physiologists have striven to discover and to demonstrate the purposefulness of all our structures and all our functions—the popular assumption being that man, if he would but live 'naturally,' has been specially and perfectly built to fit the world as he finds it. The profundities of what we may call universal psychology are, of course, too deep for our comprehension; but, so far as the observable facts go, we cannot justly say that there is much more evidence or much less evidence for one of these concepts than for the other. The very fact of man's continued existence in the world over hundreds of thousands of years implies a considerable measure of compatibility between man and his environment. But the harmony is not perfect, and little more than a temporary working compromise is possible. Disease and death would seem to be unavoidable features of man's earthly career, in spite of all our efforts—not entirely unsuccessful—to lessen the one and to postpone the other. Wonderful as is the chemico-physical—to say nothing of the psychological—mechanism of the human body, it is fair to say that, even measured by our engineering and scientific standards, scarcely a single bit of our machinery is really perfect.

Nor need we dwell on mere limitations, such as those which restrict our range of vision, of hearing, and of feeling; in almost every part of our body we find structures, rudimentary or otherwise, unfitted for use in the sort of life man lives and the posture he has adopted. The study of other animals forces us to the conclusion that many of these useless parts are but the decadent vestigial remnants of organs that may well have had value to man's pre-human ancestors living quite different kinds of lives and adopting quite other postures. The in-turned tail which forms the lowest part of our spine is a good example of such useless vestigial structures. Dozens of other illustrations might be adduced. In some cases these structures, once purposeful and useful to animals walking on four feet, have been to some extent modified and adapted so as to have a sort of makeshift utility in situations for which they are not specially fitted. But, in many cases, no such adaptation has taken place; and these remnants or leavings are nothing but a source of additional danger and difficulty to their possessors. It is probable that the vermiform appendix is such a useless and dangerous vestige.

Consider, again, our natural defences against bacterial and other sinister enemies. Against minor attacks of many common germs our cells automatically put up an effective defence. But confronted by other microscopic enemies, they seem powerless. The most seemingly vigorous man, living what we call a perfectly healthy life, is as likely as is the weakliest or the most debauched to fall victim to pneumonia, to yellow fever, to malaria, or to cancer. It would seem, therefore, to be idle to preach the doctrine that by 'returning to nature' man can escape disease and all risk of hygienic disaster. Equally foolish is it to deride as unnecessary and useless the work of the physiologists and of those who have striven and are striving to create a scientific—and therefore an artificial—system of medicine and health culture.

II—HEREDITY AND ENVIRONMENT

WHEN we hear of the arrival of a new baby we do not ask: 'What is he like?' for we know that he will be very like any other baby. We are more apt to ask: 'Who is he like?' We know that definite family resemblances are to be expected. There may be a strong resemblance to one or other parent, or the child may seem to be a blend of both, and this does not seem strange. We may find more difficult to understand, however, the repetition which one often finds in a child of some feature which is not traceable in either parent, but is familiar to us in one of the grandparents, or even in a distant relative on some collateral branch of the same stock. If we believe that these recurring features cannot be merely fortuitous, we are recognizing the main principle of heredity. We are children of the past, and we carry in our physical and mental make-up much that was transmitted to us by our parents, not from themselves only, but from the generations which preceded them.

Although the baby may be 'the image of its father,' it is by no means a replica. It is an individual, as are we all—so like our fellows, and yet so different. In the practice of medicine, and even in the application of general hygienic principles, we can never lose sight of the differences between individuals. It is, therefore, well worth while to devote a little time to the consideration of certain factors which control our resemblances and our variations.

These factors fall under three main headings: Heredity, Environment, and Function. Under Heredity we include only those things which have been transmitted concretely through the parents. We must not confuse with this the legacy which we all receive, by external means, of tradition and accumulated human knowledge and experience. Environment covers all the forces which act on us from our surroundings—the air we breathe, sunlight, nutriment, and a hundred others. These two factors, our nature and our nurture, are quite separate but entirely interdependent. Environment cannot develop anything of which the potentialities were not there at the start. Nature only provides the elements for development by suitable nurture. The third factor, Function, is possibly only a part of environment. Under this heading we include the effects of use or disuse on various specialized parts of our bodies.

FERTILIZATION

In considering heredity and environment, we must never forget the moment at which the life of the individual begins. At birth the infant

has already been developing for nine months under the influence of its environment. It is a sheltered and specialized environment certainly, and less variable than later, but it is to some extent different in each case. As explained in the chapter on Reproduction, individual life starts when the minute egg-cell of the female is penetrated by the active but still more minute sperm-cell of the male, and fertilized by it. This fertilized egg-cell must contain all the qualities, or all the possibilities, which we can ascribe to heredity.

The germ-cell of the female, the egg-cell, is comparatively large (one one-hundred-and-twenty-fifth of an inch in diameter). It has a definite envelope, a nucleus, and a good deal of cytoplasm. It probably carries a good deal of reserve matter which is used for subsistence during the period in which it is free within the body, and in the early stages after fertilization. The nucleus contains a meshwork of material called chromatin, which divides, when the cell is mature, into a definite number of bodies called chromosomes. This number is constant in every body-cell of the particular species. At the final cell division before the liberation of the ripe germ-cell the number of chromosomes is reduced to half, the chromosomes uniting in pairs before division.

The male germ-cell, or spermatozoon, is infinitely smaller than the egg-cell, perhaps one hundred-thousandth of the size. It carries little reserve matter for its brief journey. It consists of a head, which is largely composed of the nucleus, and a motile tail of cytoplasm, which propels the head against the downward currents which it encounters. In the spermatozoon, also, the number of chromosomes is reduced by half at the final division before maturity.

When one of the countless spermatozoa comes in contact with the egg-cell it penetrates the outer covering. The covering becomes hardened, excluding other spermatozoa, and the process of fertilization has begun.

There are two main results of fertilization. In the first place the nuclei of the male and female germ-cells become fused. The chromosomes do not merge, but come into intimate and orderly union, and the fertilized egg-cell thus contains the number of chromosomes normal to all cells of the species. If we believe, as we must, that the chromosomes are the vehicles of all the hereditary qualities, then the cell contains all the elements of a dual inheritance. Fertilization gives, in the second place, the impetus which starts the process of development. The chromosomes split and the cell divides, and an infinite series of redivisions follows. The embryo begins to take shape, and the specialization of various groups of cells makes possible the formation of the tissues and organs of the body.

PARTHENOGENESIS.

It is of interest to note that in a few isolated species among the lower animals an egg-cell develops into a living animal without fertilization, a process known as parthenogenesis. A similar result has been brought about artificially in certain types where it does not normally occur. Thus Delage contrived, by providing a suitable stimulus and then an appropriate environment, to rear from the unfertilized egg of a sea-urchin a sea-urchin which developed to the adult stage, and lived for three years. This is important, as it suggests that in sexual reproduction each of the germ-cells contains the essentials for development. We must accept this view if we are to try to understand how one character may be obviously of paternal origin, and another equally clearly derived from the mother. Only one of the two possible characters will be expressed in the offspring, but the dual possibilities give infinite chances of variation. In parthenogenesis there can be only one inheritance, and there seems to be evidence to suggest that the ultimate tendency is to degeneration.

THE CHROMOSOMES AND HEREDITY.

Everything that is transmitted to us directly must in some way be contained in either the male or the female germ-cell which together form the fertilized egg-cell. Of these germ-cells the most important part would seem to be the nucleus, rather than the less highly organized cytoplasm. The nuclei fuse after fertilization, but their most highly organized portions, the chromosomes, remain intact. The normal number is restored, half being paternal and half maternal in origin. The process of cell division is such that this dual representation is continued at every subsequent division, and therefore in every cell in the body. So one can hardly doubt that the chromosomes convey most if not all of our dual inheritance.

If every cell contains an equal number of chromosomes derived from each parent, then clearly the chromosomes originating in one parent, say the father, contain elements derived from his parents, and these again are derived from a preceding generation, and so back through infinite generations. The possibilities of such representation are not limited by the number of chromosomes, as parts of two chromosomes become joined at the division preceding fertilization, and this fusion occurs in each generation. Thus one chromosome might conceivably contain elements due to countless generations. Our inheritance has been called a mosaic of ancestral contributions.

There appears to be good reason to believe that in the early stages of development a portion of the original germinal material is preserved

unaltered, and that from this is derived in due course the germ-cells which give rise to the next generation. This has actually been demonstrated in many of the lower animals. For example, in the threadworm of the horse, according to Boveri, the first cleavage of the fertilized egg-cell gives rise to two cells, from one of which all the somatic or body cells are formed, from the other all the germ-cells. Weismann, one of the greatest workers in the field of heredity, maintained that in all cases the germinal material which starts an offspring is directly continuous with the germinal material from which its parents arose. He believed that there is a specific substance, which he called the germ plasm, which is borne in the chromosomes, and is the vehicle of all hereditary qualities. Germ-cells, like other cells, are subject to processes of repair and renewal, and it is on the continuity of the germ plasm, not of a series of cells, that Weismann insists. By this theory the parent is the custodian for a time of some of the germ plasm of his stock, and he may pass it on.

Galton, another of the great leaders in the field of heredity, formulated a statistical Law of Inheritance, based on a study of certain qualities, such as the stature. His conclusion was that on the average each parent contributed one-quarter of each inherited factor. Half of the remainder came from the four grandparents, and half of the other half from the great-grandparents, and so on in infinite series. Thus our inheritance is multiple, each generation back contributing on the average its definite but diminishing quota.

It is hardly possible for us to conceive the mechanism which permits the conveyance of all our hereditary qualities, through the medium of the chromosomes. Obviously only initiatives can be conveyed, potentialities which can be developed under suitable conditions, but may fail to mature or may lie dormant and be displaced by other factors. We can never forget the influence on development of environment and function, but we must not overrate it. The chick develops in the egg comparatively sheltered from external influences other than warmth, with only its hereditary outfit and the nutriment of maternal origin which the egg contains.

Some of our characters appear more fixed than others. Many are common to all human beings, unless accident or disease causes malformation or arrested development. Others are common to our race, and many of these, such as the physical characteristics of the Jew or the Negro, persist for many generations, after the original environment has been changed. Others, like the lower lip of the Hapsburgs, may be characteristic of a family, while others again are less constant. It would seem probably that our more fixed characters are those which are represented in the contributions from all or most of our sources of inheritance.

MENDEL.

Interesting light has been thrown on the mechanism of dual inheritance of characters by the work of Mendel, an Austrian monk, on the hybridization of plants. He published his results in 1866, but their importance was only realized early in this century. Mendel discovered that there were certain unit-characters which were either present or absent, but did not blend. Thus he found that in certain varieties of peas tallness and shortness were unit-characters. Tallness he called a dominant factor, shortness a recessive factor. If a tall and a short variety were crossed, the offspring all showed the dominant character of tallness. But the recessive character was still there, for if self-fertilization of the hybrids was permitted the next generation showed a definite proportion of three dominants to one recessive. Of these, self-fertilized, one dominant bred true, as did the recessive. The other two, apparently dominants, again produced the three to one proportion. From Mendel's work we conclude that we may inherit a character from one parent rather than from the other, because it is a dominant unit-character. But we must not conclude that all characters are Mendelian unit-characters following this law. Many characters blend, whilst a few are particulate, as where a blue eye contains a patch of brown. There seems a possibility, but only a possibility, that the characters of the parent who is at the time more virile will tend to predominate. From Mendel's work we can also realize that a character not expressed may be passed on, and that it may keep cropping up in succeeding generations—although by careful breeding an undesirable character can sometimes be eliminated.

Hereditary Tendencies

There are two great hereditary tendencies, one towards stabilization, the other towards variation. Our more fixed characters prevent undue variation. Our dual inheritance increases our ancestry, and thus our chances of normality. It may cancel certain tendencies or restore traits which have been eliminated. Galton's Law of Filial Regression states that children are more likely to approximate to normality in a particular direction than do their parents. There is a constant tendency to return towards the racial average. One must not take this as going against the principle of Eugenics, that the best tends to breed the best. The son of a genius need not be a genius, but he is considerably more likely to be one than is the son of a man of mediocre intellect.

There are many causes of variation in individuals. There is an infinite number of possible combinations of hereditary qualities. There may be negative variation through the losing of some element at the

first division of the chromosomes. A character may be strengthened if it is represented on both sides. The nutrition of the germ-cell may be affected by age or general ill-health.

Variation leads to Evolution. Variations are constantly recurring, and may be repeated or extended in a particular direction through the strengthening of one germinal character or the loss of another, although there is always a tendency to return sooner or later to the racial average. Darwin held that new types were evolved by a process of natural selection of continued gradual variations. The work of De Vries, however, suggests that at least a considerable part is played by mutations, sudden changes in a new direction, some of which breed true. These are presumably due to some fresh arrangement or combination of germinal elements, and it seems possible that there may be a periodic liability to change and to make experiments.

ACQUIRED CHARACTERS.

There has been much scientific controversy over the question of the inheritance of acquired characters. The question is still open, and we must content ourselves with expressing the view that it is not yet fully proved that changes wrought in the body by environment or function are ever transmitted to the offspring. Speaking generally, we do not believe that the son of a blacksmith can inherit the muscular development caused by his father's calling. He may, however, inherit the germinal tendencies to strength and good physique which made it possible for his father to become a blacksmith.

This view must colour our whole outlook on heredity and disease. Malformations and injuries due to accident are not inherited, nor are the disintegrating results of disease on the body. We may, however, inherit the tendencies or predispositions which make us more liable to develop certain diseases, and so repeat family history. These tendencies are increased by the fact that we tend to some extent to have the environments and habits of life of our parents. Thus we can account for the numerous family histories of recurring tubercular, gouty, and cardiac affections, though in tuberculosis exposure to infection plays a considerable part. Insanity is not hereditary in itself, but we may inherit the underlying nervous instability which causes the occurrence in successive generations of similar or varying mental and nervous diseases.

Certain conditions may be inherited which are not true diseases, but are defects due to the absence of a particular factor. In this class fall certain rare familial nervous diseases, colour blindness, night blindness, and haemophilia—which is a tendency to excessive bleeding, transmitted to the male through an unaffected female. Infections are never strictly hereditary, though they may be congenital, occurring before

birth. Syphilis may infect the germ-cell, tuberculosis—though rarely—the unborn child, and gonorrheal infection of the infant may occur at birth. We need not be too fatalistic about heredity and disease. We may inherit defects, or receive early infections. We may inherit instabilities or unfortunate predispositions. But variation helps—for each there is a reshuffling of the cards. We may avoid a taint, we may receive some compensation not expressed in the parent, we may overcome a predisposition by suitable environment. Transmitted taints tend to occur earlier in each generation, and so to die out.

Before turning to consider the effect of environment we may recapitulate briefly. We inherit a mosaic of ancestral tendencies and possibilities, and only what is there can be developed. But we have infinite possibilities of variation, and we are individuals not replicas. Our hereditary possibilities only become developed or expressed with suitable nurture, so there is considerable possibility of correction, and one might almost say some degree of choice.

Environment

The influence of environment comes into play from the beginning of life, the fertilization of the germ-cell. While the foetus is floating in protective fluid in its mother's womb it is only liable to damage by gross injury or pressure. It is nourished by the filtered blood of its mother, and the rapidly developing foetus is probably much more readily affected by variations in the quality of the blood than were the germ-cells in the maternal body. Although the effect of minor accidents and strains, or maternal impressions, is probably over-estimated, it is likely that acute illness of the mother, or shock and strain, sufficient to cause constitutional disturbance, may well affect development. Poor nutrition, chronic illness, overwork, or mental unrest, during pregnancy must to some extent hamper development.

During the arduous passage of the child into the world, and after birth, environmental factors become so manifold and interact so freely that one cannot hope to estimate their effect on development and health. One can only try to indicate some of the possibilities. Speaking generally, one may say that the human organism is to some extent prepared to react to environmental changes, and that it is only when these variations are abnormally great or long continued that harm may result. It is probable that minor degrees of unsuitability in environment, if long continued, are frequent causes of divergence from the best developmental path. But we are individuals, each with his personal idiosyncrasies, and what affects one may be harmless to another. Some hereditary weakness may leave us more at the mercy

of a defect in our nurture, or some strong point may make us less vulnerable than others.

There are three great worlds—the world of Inanimate Nature, the world of Living Things, and the Social World. Living beings act and react on each other continually, they are unceasingly in contact with the great forces of nature, and at every turn they are affected by the habits and traditions of society, by occupation, and by the conditions imposed by civilization. The interactions between these worlds make up our lives.

To many external conditions man is biologically attuned, and adaptation to meet their minor variations can be made without conscious effort. The force of gravity is constant. The pressure of the atmosphere on the body, and the composition of the air we breathe, are sufficiently constant to make adjustment simple. The somewhat depressant effects of humidity are compensated by succeeding spells of stimulating dryness. In the same way the changes from direct sunlight to diffused daylight, and from brisk air-movement to quiet, normally elicit simple responses of accommodation, and make possible the receipt of frequent stimulation. The regular cyclic changes of day and night coincide, in natural conditions, with our required spells of activity and rest. Only when such changes of natural or artificial external conditions are in excess can we regard them as deleterious to health.

The air contains the oxygen which is essential at every minute of our lives. The chemical processes of the body are essentially processes of combustion or oxidation. The percentage of oxygen in the air varies very little in normal circumstances, but if we breathe a vitiated atmosphere, or if the air be too damp, it is more difficult to obtain the amount of oxygen we need, and deeper breathing and harder work by the heart is necessary to get the requisite supply. The result is fatigue, and in extreme cases overstrain. We are placed in a position comparable to that of the patient whose lungs are clogged by disease so that aeration is impeded. Dust or other particles in the air also prevent free breathing, and we all know the enervating effects of a London fog. In a year of continued fog the effect on the death rate and on the incidence of respiratory complaints is very marked. An overcrowded or ill-ventilated room quickly causes depression and fatigue. The amount of air pollution may be estimated by measuring the excess of carbon dioxide over the normal, but the effects appear to be due less to this excess than to the lack of air-movement. Moving air stimulates breathing, favours evaporation, and aids the dispersal of excess of bacteria, cellular debris, and inorganic particles in the air. Wind is a natural stimulant to breathing, though we must sometimes temper the blast. Fresh air encourages secretion, preventing that drying of the mucous membranes which causes increased liability to infection.

Fresh air is beneficial, but a severe draught is not. A draught may cause undue cooling of some portion of the body, calling for excess of heat production to counteract it.

We all know the feeling of well-being engendered by a sunny day. Sunshine is not only a physical but a mental tonic, and one must never forget that contentment and mental well-being have a definite effect on our physical condition. In recent years the public have realized very fully the value of real exposure to sunlight, and there is perhaps even a tendency to overdo it. Sudden and prolonged exposure to intense sunlight will cause harmful burning, and possibly even sunstroke. One *must go warily, and aim at producing bronzing rather than burning.* The brown pigment gives us a protection which enables us to make use of the stimulus of sunshine without harm. In recent years it has been found that the beneficial ultra-violet rays of sunshine can be provided artificially by lamps, and so can be available at need. Again over-use has sometimes led to disappointment. Like any other tonic, sunlight can only repair a deficiency, if such exists. It has, therefore, no value in excess, or to those who have no deficiency. Sunlight is a valuable disinfectant, a killer of micro-organisms. It is essential to the building-up of green plants, on which our food supply ultimately depends. To our bodies it is an aid to metabolism, as well as a general tonic. Rickets is a disease of maldevelopment due primarily to a deficiency of Vitamin D, which appears to exercise some control over growth and development. It has been shown that sunlight has a complementary action, and that its application will to some extent counteract the vitamin deficiency. One can see, therefore, that poor lighting, like bad ventilation, in homes and workplaces, is a real danger to health, especially in large cities where fog and atmospheric pollution diminish the amount of available sunshine out-of-doors.

The sun is our natural source of warmth, but we have learnt to augment it artificially. Overheating or overclothing promotes perspiration, which should be counteracted by evaporation. If this is prevented by unsuitable clothing, bad ventilation, or an unhealthy skin, the heart must drive more blood to the skin to cool it, thus possibly causing strain and fatigue, and the withdrawal of some of the blood-supply from the brain and the internal organs. To cold we react by a reflex tightening of the skin and constriction of its blood-vessels, thus reducing the evaporating surface. Exercise will increase the body heat, but extra food is necessary to keep this up, and cold is a real danger to the ill-nourished, and to the very young or the aged, whose reactive powers are low. Civilized man will rely to some extent on protection and artificial heating, but in health we should aim as far as possible at the counteracting of temperature variations by the natural heat-regulating mechanisms of the body.

Exercise produces heat, stimulates the heart, keeps our muscles in good working order, and aids the elimination of waste products. Rest is all-important, and is the great healer. In health not only sleep but periods of relaxation are essential to compensate for times of greater physical and mental activity.

Thus we see that our bodies are well fitted to adapt themselves to the normal variations in climate and other external conditions, but that there are dangers to health and development in extremes, and in minor but cumulative deficiencies with regard to fresh air, sunlight, rest, and exercise. Civilization adds to our natural environment housing, clothing, artificial heating, and controlled ventilation, and we must have due regard to their suitability.

All through life our body processes are at the mercy of the diet which is supplied. Diet is perhaps the environmental factor which has the greatest possibilities of variation, although unless economic difficulties are too great it is the one over which we have most control. Our digestive system has certain powers of selection and rejection, and of accommodation to minor unsuitabilities of diet, but the essentials must be provided, and a bad balance may cause serious and cumulative trouble. This problem is dealt with in the chapter dealing with Nutrition, and here we need only stress the importance of diet as an environmental factor. For perfect health and proper development we require a diet containing in suitable form and proportion the necessary groups of chemical constituents. The diet must also contain a sufficient quantity of certain fresh foods to give us the small but regular supply which we require of the various vitamins or accessory food-factors. It is probable that most of us are in little danger of the acute diseases which are caused by deficiency of one or another of the vitamins, but the possibility of troubles due to minor but continued deficiencies is less remote.

Reference has been made to the importance of the hormones secreted by the ductless glands of our bodies, and to their effect on growth and development. It is possible that these internal controlling forces are affected by environmental conditions, and that disturbance of the balance of these secretions may be in some cases due to vitamin shortage, for both the vitamins and the hormones appear to act as regulators of the processes of metabolism in the body. Similarly, the absence of certain essential mineral salts, found in the same fresh foods as those which contain our vitamin supply, may affect the balance of our internal secretions.

Our occupation necessarily affects our environment, both directly and through the fact that in civilization our external conditions tend to vary a good deal with our earning power. We spend much of our lives at work, and if the occupation be too arduous for our particular

powers, or if our work is in unsuitable conditions, our health must be affected. Excess of dust, fumes, heat, or damp each bring their troubles, and lack of air and sunlight are as harmful at work as at home. Occupation affects our functions, the use or disuse of our parts or qualities. Use or education of an organ or a mental quality leads to development, while disuse may lead to deterioration.

One cannot make a silk purse out of a sow's ear. We cannot develop anything which our hereditary equipment does not supply. But suitable environment, use, and wise guidance, can do much to make the best of the available material, to encourage the good qualities, and to suppress the less desirable elements. We must not be fatalistic, for we can do much to control our health and our lives.

III—THE PERSONAL CARE OF HEALTH

Public Health

The story of Public Health administration in this country is a very creditable one. Since the Government assumed responsibility for the physical well-being of the people, as it did in the Public Health Acts of the seventies, the progress has been rapid and uninterrupted. From the Ministry of Health downwards, authorities have been constituted in county, borough, urban, and rural districts, and invested with extensive powers which, under the spirited guidance of their enlightened medical officers, have almost everywhere been fully and wisely utilized for the public benefit. Pure water, efficient drainage, disposal of refuse, wholesome milk, untainted food, are only some of the blessings which have been conferred upon this generation by progressive administrators. The plague, pestilence, and famine which our immediate forbears regarded as due to the will of an inscrutable Providence, have receded rapidly before the research work of the quiet and unassuming labourers in this field, the really great men who have completed for us the conquest of such scourges as typhus, cholera, and plague, and have shown the way to the annihilation of malaria, dysentery, black-water fever, and many another white man's bane in tropical and subtropical countries. As the result of their labours we can point at home to a diminution in the incidence and an attenuation of the virulence of many fell diseases, including tuberculosis. We have only to look at the lowered death-rate, especially among children, and the increased general longevity, to realize that the conditions of life have, in the last fifty years, improved out of all recognition. A good deal of this work has been accomplished in the teeth of the powerful opposition represented by natural conservatism and vested interests; for the gospel of public sanitation fell at first upon unreceptive ears. It is now, however, so firmly established that there is little danger of backsliding.

Personal Hygiene and Prevention

It must, unfortunately, be confessed that the progress of personal hygiene has not kept pace with these advances in public health. Scepticism and conservatism in matters of self-care are still far too general. Vast numbers of people still cling to the erroneous theories of their

forefathers in such matters as diet, clothing, fresh air, and exercise; and the task of persuading them to reform is not an easy one. Nevertheless, considerable progress has been made in the last twenty years. The Great War was instrumental in teaching at the front that cold and wet are not lethal, and at home that moderation in diet is beneficial. It is the mission of the present generation of health-reformers to carry on this good work, to explain to educated people the essentials of healthy existence, so that they may lead their animal life in such a way as to enable them more thoroughly to appreciate the things of the spirit.

Herbert Spencer, the Victorian philosopher, who died in 1903 at the age of eighty-three, taught that the preservation of health is a duty. 'Few,' he said, 'seem to realize that there is such a thing as physical morality.' This desirable attitude of mind has attained considerable popularity since his time. Far more people take an intelligent interest in matters of health than did so at the beginning of the century. From Lister's day to that time, and indeed for many years afterwards, the whole health outlook, both of the public and of the medical profession, was dominated by fear of the microbe. Disease was regarded as inevitable, a thing due to the caprice of a Puck-like Providence; and in its presence all efforts were concentrated on the search for the casual microbe and its extermination by means of antiseptics. Disease was studied, not health; not prevention, but cure; and illness was spoken of in terms of its appropriate drug. The maleficent seed was everything; the defensive soil, nothing.

We are, however, at last beginning to give due prominence to the other side of the account; we are coming to realize that, after all, man is stronger than the microbe, and that, if we cultivate the defences with which Nature has endowed us, the victory is nearly always with us. The power of the defensive endowment emerges most strikingly in all recent discoveries in medical science, whether they be in the fields of surgery or bacteriology, or in those of endocrinology or biochemistry.

SURGERY.

In surgery the work of Lister and Pasteur pointed in the direction of prevention, could their disciples but have perceived the fact. The discoveries were used, at first at any rate, to neutralize infection, not to prevent it. Prevention followed, but after a long interval. To-day, a suppurating wound is regarded as a grave reproach to the surgeon, because it means that he has failed to utilize all the means for prevention that are now so abundantly at his disposal. The recognition of prevention as the guiding principle, and its cultivation down to the minutest detail, have enabled to be employed and carried to a triumphant conclusion surgical measures which in the days of 'cures' could never have

been undertaken. This new note of the paramount importance of prevention is emphatic, even in the domain of bacteriology—the citadel of the omnipresent microbe.

BACTERIOLOGY.

The masters of this science tell us that most of the pathogenic germs —pneumococcus, diphtheria bacillus, the enteric group, and many others of less importance—are permanent residents in the tissues of perfectly healthy people; and that it is only when such people have lowered their resistance by hygienic misdeeds that the germs make a sortie against the weakened defences and give rise to disease. Most of us, when young, suffer from slight attacks of maladies which in their full efflorescence are highly dangerous; but our defences being in good order we are able to throw off with a headache, or a slight cough, or an attack of diarrhoea, an infection which in a less favourable state of our defences would have meant several weeks in bed and a prolonged convalescence. A consideration which emphasizes the importance, in the causation of disease, of the human soil as against the microbic seed, is the behaviour in the human body of a bacillus, now so well known that its name, *bacillus coli communis*, has already tripped gaily off the tongue of several generations of interested laymen. This bacillus, of which there are several types, inhabits the intestinal tract; and the predominating type is found to vary enormously with the nature of the food consumed by its host. It is not so much that the bacillus coli communis changes its type according to his diet, as that differing diets encourage different breeds to grow and predominate. Some of these breeds are our very good friends, and our ready helps in defeating our enemies of the putrefactive kinds. Thus, it is evident that not only will a suitable soil defeat enemy germs by direct means, but it can also, by methods of dietetic diplomacy, convert a virulent enemy into a good neighbour.

ENDOCRINOLOGY AND BIOCHEMISTRY.

The note of confident defiance thus conspicuous in bacteriology is predominant also in endocrinology. With a proper hormonic balance we are masters in any field. Our resources against enemy poisons, whether microbic or otherwise, are quickly mobilized and effectively employed. In the field of biochemistry it is the same. To look back upon the pre-vitamin days, and to contemplate the clumsy flounderings in anti-microbic dietetics, which prescribed everything boiled, and banned everything raw, is to marvel that there were not more C3 candidates for military commissions than there actually were.

Mistaken Ideas of Health

It is unfortunately the case that, so far as the general public is concerned, most of this recent knowledge in matters medical is still a sealed book. The knowledge is spreading, but it has not yet reached the stratum in society most in need of this kind of enlightenment. This stratum is typically represented by the fat, bald, prosperous man of fifty, who enjoys life, and demands of medical science only that it shall afford him the means of sinning against the laws of health without suffering. He knows nothing about those laws, and is very impatient if they are pointed out to him. He wants to do as he pleases, and to be protected from unpleasant consequences by his doctor. Having smoked tobacco to dirty pyorrhoeic excess, he soothes the resulting cough by lozenges, gargles, and sprays; remedies against which the only thing to be urged is that they are far too efficacious. His insomnia he cures with aspirin, his lethargic obesity with thyroid tablets, and his acidity by an extra glass of milk at bedtime. His psychology is obstinately and even aggressively obscurantist. Everything in the direction of moderation and restraint is a stupid fad. He eats generously and drinks freely, and is unable to believe that the things which he enjoys can do him any harm.

THE LACK OF SIMPLICITY.

Another thread which runs conspicuously through all the recent discoveries in medicine, which the general public find it hard to appreciate, is simplicity. Man's astounding success in so many fields of endeavour has begotten in him a false sense of proportion. When he contemplates a battleship or an aeroplane, or listens to a gramophone or a wireless, he is filled with a legitimate pride in his power and ingenuity, and not unnaturally persuades himself that he is, or ought to be, as transcendent in the physiological world as he is in the physical. He finds it difficult to recognize any solidarity between himself and the brute beasts which have no understanding. He feels that he ought to be able to manipulate and harness the vital forces even as he has harnessed the physical, and it will take him a long time and much suffering before he realizes that he cannot. In his endeavour to improve upon Nature he has swept simplicity on one side and substituted elaboration. This is well seen in the important matter of food. He has brought the artificial elaboration of his diet by means of cooking and otherwise to such a point that it is now hard for him to believe that simple uncooked foods are not only permissible, but are in some degree essential. The clothing which he has elaborated from very simple beginnings is now used less for protection against cold than for embellishment and class distinction. Freedom of movement is impaired by tight collars, tight

waists, and other contractions which interfere with the circulation of the blood. But man's clothing still errs grossly on the side of excess. He seeks to protect himself, not against undue cold, but against all degrees of cold. He thinks he knows better than Nature, who has given him a skin with astonishing powers of adaptability and adjustment, so he multiplies wraps where he ought to diminish them. He has not yet learnt that the more he wears the more he seems to require, because by increasing his clothing he lessens his adaptability. To-day woman is wiser, and she is teaching him.

Primitive man found it necessary to protect himself against inclement weather and the attacks of enemy beasts by building for himself huts and shanties. These were rude structures which admitted plenty of air and light. Man's ingenuity has evolved from them the modern house, centrally heated and capable of excluding every breath of air and every gleam of sunlight. The beneficent campaigns in favour of the open window and the ultra-violet rays have done much to remedy the harm which hermetically sealed and darkened rooms wrought in breeding and promoting diseases of the lungs and in stunting children's growth; but much remains to be done.

THE 'CHILL.'

The persistent false emphasis laid on the importance of the microbic seed, to the detriment of the cultivation of the resistant soil, together with the curious glamour of mystery with which all disease seems to surround itself, have combined to perpetuate the assumption that all maladies which cannot be attributed to a microbe, and many which can, are due to a 'chill.' What exactly is meant by the word 'chill,' no one seems to know. The theory probably originated in the days when vague fevers of an undifferentiated type, now, happily, abolished by sound sanitation, were exceedingly common. These fevers, being of a malarial type, were ushered in by feelings of chilliness, as many slight rises of temperature still are, and people, mistaking these chilly feelings for the cause of the disease, invested 'chills' with a degree of power and importance to which they have never been justly entitled. Had the story stopped there, no harm would have been done; but the chill theory has been, and still is, responsible for many obstinately shut windows, and for a degree of overclothing, especially of children, which does incalculable harm.

FOOD AND EXERCISE.

It is probably in the matter of due balance between intake of food and output of muscular exercise that man is most apt to claim a difference from the rest of the animal kingdom. He will not understand that, physiologically speaking, food is merely a means to an end, and

that, logically, no more of it should be taken than suffices to achieve that end, which is the maintenance of life on its highest level. Food is to man what coal is to a fire in an open grate; for food is actually burned in the body, mainly by muscular contractions, and, unless the amount of muscular work suffices to burn up the food, the wheels of our being become clogged, just as, when full of cinders, the coal fire smokes. Primeval man was obliged to exercise his muscles in order to obtain food. If he did not hunt his game or till the earth, he starved. Civilized man neither hunts his game nor tills the earth, but he does not starve. He eats plentifully, but he does not, unfortunately, see the necessity for taking exercise in the same proportion. Some there are, especially in this country, who seem when young instinctively to recognize the necessity for muscular exertion. The majority even of these gradually give it up as they approach middle-age; but instead of lessening their food intake, they increase it—some, because they frankly enjoy it; others because they believe it necessary to health.

It is very difficult to induce even highly educated and intelligent people to seize the idea that man lives by what he digests and not by what he eats. If, being in good health, he eats in excess of his immediate requirements, the overplus is stored away in the form of fat, against a lean period. If he is not in good health when he takes in the overplus he is unable to digest it and stow it away, so that it remains in his stomach and acts as an irritant. So far, then, from giving strength, an excess of food exhausts the digestive organs in a fruitless attempt to assimilate it, and gives rise to indigestion. This is what is likely to happen when a large eater gives up exercise entirely, or reduces it to the unscientific level of two rounds of golf on Saturday and Sunday—unscientific, because a week's muscular exercise crowded into a week-end is apt to lead to fatigue and attendant alcohol. The proper adjustment would be to redress the balance of diminished exercise by diminished food. Englishmen have made a fetish of violent exercise. This is a mistake, partly because such artificial outbursts are time-consuming, and partly because the body thereby becomes accustomed to a rapid and complete combustion of food-stuffs, setting a standard which cannot be maintained as the years advance, so that later the proper balance between intake and output is disturbed. Prolonged strenuous exercise of a spasmodic kind should be replaced by regular exercise on an increasingly moderate level, as soon as the days of pupillage give place to the serious business of life.

INSOMNIA.

The rapid pace at which life is now lived is alleged to have increased the tendency to sleeplessness which besets many nervous people. There is probably some truth in this; for mechanical advances are often

accompanied by an increase in noise—though as they are perfected this again decreases—and relative quiet is essential to sound sleep. There is certainly a subconscious awareness of noise, even though one sleeps. It is, on the other hand, also true that many people invite their own insomnia by demanding sleep, as it were, with clenched fists. This attitude defeats its purpose. Sleep is a coy maiden who refuses to be taken *vi et armis*. If she is treated as a matter of course, even with a certain amount of contempt, she will usually do what is expected of her. But sleeplessness is often far from being an affliction of the nervous system, caused by anxiety and emotional worries. It is much more often due to digestive troubles. A very slight degree of flatulent dyspepsia will cause a troublesome degree of insomnia, and if this is repeated for several nights in succession the situation gets on the patient's nerves, and he is liable to take to drugs and such-like folly. A simple antacid tablet of soda mint, or something of that kind, generally suffices to settle the dyspepsia and the despair at the same time.

A frequent and usually unsuspected cause of sleeplessness is the last pipe before going to bed. Some people, without knowing it, have an idiosyncrasy to tobacco. Contrary to the general supposition, in such people smoking irritates the nervous system, especially the nerves of the digestive system, and they ought never to smoke. A routine measure against insomnia which has much to recommend it is a hot bath at night. Sleep is induced by absence of blood from the brain area, and by withdrawing the blood from the head to the rest of the body, a warm bath produces the physical state most conducive to sleep. Some people take a glass of milk and a biscuit at bedtime in order to prevent insomnia; and inasmuch as anything put into the stomach withdraws blood from the brain, the glass of milk may well have the effect claimed for it. Unfortunately, however, such a step produces other effects more remote in their manifestation, which are altogether undesirable. An alcoholic so-called 'night-cap' is, in many ways, preferable to milk; but that, too, has disadvantages which counterbalance its merits.

IV—FOOD AND DIGESTION

THE REFINING OF FOOD

FOR ordinary purposes anything may be considered as food which, when taken into the body, is capable of supplying material for growth and the repair of waste, or for furnishing energy for bodily heat and work. Man being the only animal who does not know instinctively how to select his food, the science of dietetics has arisen; and man being the only animal who cooks his food, this science of dietetics has become increasingly complicated as man's food has come to be further and further removed from the simplicities of his primeval state. It is important for us to remember that all our knowledge of food values has been derived from the study of simple natural uncooked food-stuffs, and that the ordinary meals of civilized man to-day are for the most part composed of materials which, by cookery and chemical refinement, have been rendered less suited to the digestive organs of ordinary healthy people. The changes wrought by cookery and refinement may be agreeable to the cultivated and artistic taste of the consumers, but it is certain that many of such changes render the foods much less easy of digestion than they are in their raw natural state. And it is equally certain that cookery, especially when prolonged and elaborate, is apt to deprive food of highly important, though imponderable, ingredients. It is a grave mistake to suppose, as is so often done, that natural uncooked foods are indigestible. A glass of raw milk is far more easily digested than a piece of boiled meat with greens and potatoes, followed by a rice pudding, but, to most of us, it is less interesting. It is possibly true that people who have been brought up on artificial foods are at first unable to digest natural foods, but a very short apprenticeship will restore the normal capacity. It must of course be conceded that cooking renders some foods more easily disintegrated in the digestive organs, and that organs thus pampered may at first rebel at crudities.

ROUGHAGE.

A serious objection to concentrated and refined foods is that they contain no 'roughage,' as it is called. By roughage is meant material in the food which is, by its nature, incapable of absorption. The part which such material plays is a very important one. It is present

typically in green vegetables and wholemeal bread. It supplies bulk to the food, and gives the digestive passages something to catch hold of. In the absence of such bulky residue these passages are deprived of a necessary mechanical stimulus, and fail in the performance of their function, with constipation as a common outstanding result. Nor must it be supposed that the absence of roughage is a merely mechanical matter; for the material which is cast aside in a so-called 'refining' process may have very considerable value in aiding digestion and nutrition.

CATALYSTS.

There are in Nature certain substances called catalysts about which not very much is known, but it is established that by their presence alone they can set in action chemical processes, which would otherwise remain inert, without themselves undergoing any change whatever —as, for instance, peroxide of hydrogen may be decomposed by the presence of metallic silver, whilst the silver itself undergoes no chemical change. Recent researches render it more than probable that in the material provided by Nature for man's consumption there are a certain number of catalysts; substances, that is, the presence of which enables the digestive organs to deal with the foods with which they are associated in Nature; whereas their abolition, by refinement or concentration, renders such foods relatively indigestible.

It must not be supposed that relative indigestibility shows itself by any outstanding symptoms. Between altogether indigestible things, such as woody fibre and a horse's hoof, to a food such as fresh human milk, which is rapidly, completely, and easily absorbed, there are many stages. Those nearest to the woody fibre end of the scale contain substances which, though the digestive organs eventually succeed in converting and utilizing them, demand the expenditure of such an amount of energy that a person who may be quite unconscious of any digestive difficulties may yet be rendered lethargic and irritable by the diversion of energy from its proper channels into the digestive tract. This kind of unobtrusive indigestion is responsible for a great many symptoms which are seldom attributed to their true cause.

Variety of Food

These considerations have a bearing upon another factor which demands a place in every successful scheme of dietetics, namely, variety. There are many people who allow their digestive organs to become 'bored' or 'stale,' so to speak, because they have become slaves to regularity, and to what they regard as suitability. The regular weekly round of the same foods at the same hours on the same days becomes a

sort of treadmill to the satiated senses. However correct the meals may be from the chemical point of view, their sameness means that the digestive organs are deprived of the normal stimulus of appetite. The victim eats the food because it has been provided for him, but he eats it without relish, and digests it with difficulty. That variety is desirable is shown by the diversity of foods which Nature furnishes for our use at the different seasons. The weariness of *toujours perdrix* does not apply only to delicacies.

Into any discussion of this kind there must always enter the disturbing element presented by differing capacities of different individuals for dealing adequately with certain kinds of food. It is undoubtedly correct to say that in their physiological make-up some people tend to revert to their carnivorous ancestors, and are happy only when deriving the major portion of their sustenance from the animal kingdom; while there are others who display their herbivorous heredity by their inability to deal adequately with meat foods without invoking disagreeable symptoms. Both of these types are quite sound and normal, but they are physiologically happy and comfortable only when they are able to select their food with due regard to their physiological peculiarities. A perfectly healthy inhabitant of the temperate zone should, in theory, be able to digest and utilize any of the ordinary foods in common use, but in practice it is found that the artificial life which is forced upon most town-dwellers has its repercussion upon their digestive capacities. The citizen's power of dealing with meat foods shows a definite decline as soon as his athletic period is over, and such foods become more and more harmful to him as the years advance. His increasingly inactive muscles fail to burn up the fleshy toxins, which accordingly deposit themselves in his joints and elsewhere. Foods derived from the vegetable kingdom are not so deadly in their potentialities as are the flesh foods. The man who hunts his game with arm and sinew is physiologically entitled to eat it; but the man who watches the operation in pictures from a cinema *fauteuil* is not. Such a one as the latter should eat little flesh, and plenty of eggs, fruit, and dairy produce.

The differences between the types of food derived from the animal and vegetable kingdoms respectively are, in reality, much more fundamental than would appear at first sight. All our foods are derived from plants, or from animals which have lived on plants. In fresh food there are certain highly important substances called vitamins, to which detailed reference will be made later; but it is relevant here to point out that the vegetable kingdom is the source of all of these; and that, roughly speaking, it may be said that cookery, especially prolonged cookery, effectually destroys the principal vitamins. Setting these facts side by side, we see that flesh foods must, so to speak, borrow their vitamins from a vegetable source; and, inasmuch as all flesh is cooked

before it is eaten, such vitamins as it contains are in serious danger of being by that process diminished below the standard of safety, if not entirely abolished. Fortunately most people now live on a mixed dietary, in which vitamins are well represented by raw fruits, salads, and so on.

Quantity of Food

The quantity of food required by any individual depends upon many considerations, some of which are obvious, while others are not so immediately clear. It is, for example, obvious that a labourer who works his muscles hard for eight hours daily will require more food than the clerk who sits on a stool adding columns of figures for the same period; that days of external cold demand that more fuel shall be burned in the body than on days of tropical heat, for which reason the denizens of the temperate regions take and require more muscular exercise than do those of the tropical. But it is by no means easy to explain 'the appetite which comes with eating,' or to find a sufficient reason for the fact that brain work in the study often creates a desire for food even more insistent than does an equivalent amount of exercise in the open air. That the nervous system plays a large part in wasting or in using up food is well seen in the emaciation brought about by continued loss of sleep. It is indeed true that many people habitually demand more food in periods of severe mental stress than they do in ordinary circumstances.

It is, however, in general, correct to say that the subconscious or physiological demand for food, after the growing period, is determined by the expenditure of material in work and energy. Most people learn naturally to preserve a physiological balance between intake and output, the kind of balance which experience teaches them is best suited to their needs. There are 'fat kine' and 'lean kine,' and both are individually normal so far as maintenance of efficiency is concerned—but that does not alter the fact that the lean kine last longer.

The food requirements of the individual vary with age and sex. In young people, during the growing period, the need for food is necessarily larger than it is later on, when material is wanted for maintenance only, and not for the formation of new tissue. The period round about the age of puberty, and that of the passage from adolescence into complete adult life, demand nutritive material for all the systems, more especially the nervous system, far in excess of demands in less critical periods. As the years advance, the physiological necessity for food gradually declines, while the appetite unfortunately does not; and as the monetary power of satisfying the appetite often increases, the period about middle age is apt to be punctuated by symptoms pointing to a surfeit of mild degree. It is a fortunate thing when the surfeit declares itself in unmistakable obesity, for then the victim's own vanity or the criticisms

of his friends may lead to improvement. If, however, the surfeit is shy of showing itself outwardly, it may work inwardly upon heart and arteries, and other vital organs, whose implication may not be discovered until irreparable damage has been done. The advent of middle age should carry with it a serious warning to men and women that they should suit the amount of their food rather to their real physiological requirements than to their capacity for enjoying the pleasures of the table. It is sad that when we can at last afford to pay for longed-for luxuries, Nature will have none of them.

If reduction in quantity and a return to simplicity in quality are the dietetic reforms demanded by middle age, the need for them in old age is even more imperative. The person who attains to real longevity does so usually on a diet which to the ordinary person will seem fantastically inadequate; yet people are for ever urging old folk to take more and more food in order to 'keep up their strength.' Woman, even during her reproductive period, requires less food than the ordinary man, owing, no doubt, to her smaller output of muscular energy.

Quality and Composition of Food

It needs very little imagination to realize that, the life of the individual being a continuous process of waste and repair, the exact nature of the material used for such repair is a matter of paramount importance. What we eat will, in the long run, determine what we physiologically are. If, from childhood onwards, we eat the right things, by middle age we shall have built up for ourselves a 'strong constitution,' as it is called. This means that we shall have developed a natural resistance to microbic and other attacks from outside, and learnt how to deal with minor derangements from within. The man who has been well brought up physically, who at the age of thirty is vigorous and wholesome, has been given a real opportunity of 'expressing himself,' as the saying is. He is not at every turn obliged to consider his physical needs; he takes his muscular strength and freedom from pain for granted, and is consequently able to throw his whole energy into the development of his character and the prosecution of his work in the world. The other side of the picture is presented by the weakling of the same age who, owing to faulty feeding on over-cooked and over-refined foods, has had adenoids at five and appendicitis at ten; and has now rickety bones and under-developed muscles. He is seldom really ill, but often has catarrhs, sore throats, and irregular temperatures. He cares nothing for outdoor pursuits, and work in the study gives him headaches. He may live to a good age, but his passage through life, instead of a triumphant march, will be a series of petty and querulous rear-guard actions. If he had been properly fed during infancy, childhood,

and youth, he would, in spite of possible hereditary taints and drawbacks, have reached maturity as a worthy specimen of his race.

It is interesting to speculate on the extent to which what we eat determines what we become. Some people, thinking to build up strong children, and deeply imbued with the conviction that the only foods containing any real nutriment are the meat foods, especially 'the roast beef of old England,' begin, as soon as the child is weaned, the process of stuffing him with flesh foods (which he is encouraged to eat nearly raw); a course which continues usually up to middle age. Apart from the strain upon the excretory organs which such a regime entails, the wholesale ingestion of flesh seems in many cases to have a harmful repercussion upon the character of the ingester. He may be quite a good—too good—physical specimen, but he grows to resemble a carnivorous animal in his nature. He is often assertive, dictatorial, combative, and irritable. Those who are responsible for his upbringing may deplore his faults and his consequent unpopularity, but they are very reluctant to admit that 'good sound food' can have had an unfavourable influence on his character.

The material of which food is composed may be allocated to one or more of certain comprehensive chemical categories or groups, called the proximate principles. The chief of these are the proteins, the carbohydrates, the fats, and the mineral salts, together with substances known as vitamins, and others known as catalysts, which have already been mentioned. It is unfortunate that our knowledge of these matters is still so incomplete as to necessitate rather complicated conceptions. Simplicity will doubtless come later. In the meantime it is desirable here to define certain technical terms which are likely to insinuate themselves in spite of the most determined attempts to exclude them.

CALORIES.

'The standard of heat-production is called the Calorie, which is the amount of heat required to raise one litre of water 1° C. or, what comes to the same thing, to raise one pound of water 4° F. . . . The question naturally arises: "Is such a combustion true for the body? does the body oxidize foods as they are oxidized in the bomb-calorimeter?" The answer is that "it does not."' The foregoing, which is a quotation from a recent authoritative textbook on Dietetics, shows that the calorie is really a very unsatisfactory standard. It will be employed here as little as possible, but a definition of it has been deemed advisable in view of the fact that it is very commonly used in modern discussions on food.

METABOLISM.

Metabolism, or tissue change, is defined as the chemical changes which occur in the tissues of a living organism. It is a concomitant

of all life and growth, and is the source of the energy liberated in the body for the purposes of movement and the production of heat. It is convenient to regard these changes as of two types: (*a*) in which simple chemical substances are built up or synthetized into more complex forms; and (*b*) in which complex chemical substances are broken down into simpler ones. To the former (*a*) the term 'anabolism' is applied; the latter (*b*) is called 'katabolism.'

PROTEINS.

Proteins are complicated substances, composed largely of nitrogen, upon which the body relies for its maintenance of metabolism. They are therefore essential constituents of all dietaries. Proteins are found largely in flesh foods, butcher's meat, fish, poultry, game, eggs, and cheese; they are also present in considerable quantity in certain vegetables, notably peas, beans, and lentils. The ordinary diet of civilized man, certainly of the well-to-do, in the temperate zone tends to contain too much rather than too little protein.

CARBOHYDRATES.

The carbohydrates consist mainly of starches and sugars. Starches are present in considerable quantities in rice and potatoes; bread contains starch, so do green vegetables, fruits, and nuts. Before starch can be digested it must be converted into sugar, a process which demands a good deal of energy. When the digestive organs are fatigued by an excessive amount of this conversion, the result is a form of indigestion which, unless its real meaning be recognized, is apt to give rise to considerable trouble. Not all sugars are easily absorbed; only those which are found in Nature, such as those present in fruits and vegetables and in honey, are readily digestible, and it is into this kind of sugar that starches are converted in the body so as to render them easy of digestion. Several kinds of sugar exist in food-stuffs, and they must all be converted into the easily digestible form before they can be utilized by the body. Certain forms of sugar, therefore, in addition to the starches, if taken in excess, are liable to fatigue the conversion apparatus and cause indigestion. White commercial sugar, as we know it, is a highly refined artificial product, which is more difficult of conversion than starch, starch being a natural substance for the conversion of which due provision is made in our digestive apparatus. Refined sugars are foreigners and intruders, for which no provision has been made; they, in consequence, tire the converting mechanism and irritate the mucous membranes. People speak about 'sugar' as though it were a distinct chemical entity with no varieties. It would be just as reasonable to speak of 'oil' without differentiating between paraffin and salad oil.

The importance of sugar as a food is so great that we should endeavour

By courtesy of the Trustees of the British Museum

SETTING BONES IN SPLINTS

Reducing fractures and dislocations

From a treatise translated into thirteenth-century French from MS. of 1180

to obtain a working knowledge of the position occupied by the several varieties of the substance in ordinary dietetics. This is not meant to encourage undue concentration on dietetics in general, or on any branch of it, but merely to set out a few facts which have an important bearing upon the maintenance of health. It is convenient to divide sugars into two categories, which may be called: (1) the single, or simple, sugars, such as grape sugar, fruit sugar, and honey sugar; and (2) the double, or complex, sugars, such as cane sugar and beet sugar. Grape sugar can be made artificially by boiling starch with acids. When heated it turns brown, and is used in cookery as 'sugar colouring.' Mixed with white of egg, it is employed in the preparation of icing, and in the manufacture of bon-bons. It is relatively easy of digestion.

Fruit sugar is very easy of digestion. This is no doubt partly due to the fact that it cannot be extracted from any fruits because it is uncrystallizable, which means that it is necessarily eaten in conjunction with other substances with which it is found associated and, so to speak, diluted, in Nature. It cannot be divorced from the substances whose presence with it renders it easy of digestion. Honey also belongs to the class of single simple natural sugars which are easy of digestion. The honeycomb wax is not digested. It acts as roughage.

The double or complex sugars are represented chiefly by cane sugar and beet sugar, both of which, as we know them, are highly refined and concentrated articles which have been completely divorced from the substances with which they are associated in Nature. Their degree of concentration may be gauged from the surprising fact that it requires about fifty sticks of ordinary sugar-cane to make one pound of loaf sugar. Every ordinary lump of sugar is equal to about two feet of cane. Children, therefore, frequently eat the equivalent of twelve feet of sugar-cane in a few minutes, while many adults consume the equivalent of two to six feet of sugar-cane in a cup of tea. These facts are all the more perturbing when one realizes that cane sugar in solution is an irritant to the tissues. In contact with the unbroken skin it is liable to set up violent inflammation; and rashes produced in this way may often be seen on the arms of grocers and other persons who handle sugar. Injected under the skin it causes a very painful condition. It seems likely that it can have an irritating effect upon the delicate lining of children's stomachs, and may even produce in adults a chronic irritation which may have serious consequences.

In the preparation from the crude cane of the refined white loaf or lump sugar as seen on the English tea-table, there are several stages, and some by-products result. Among such are treacle, molasses, and golden syrup, all of which, from the fact that they still retain many of the substances found in the sugar-cane (called impurities) which render the sugar more digestible, are from the dietetic point of view much to

be preferred to the concentrated loaf sugar. Unfortunately, on account of their syrupy consistence and absence of 'refinement,' these desirable substances are not popular. An effort should be made to reinstate them in general favour. There are sugars which, though still containing the despised 'impurities' in appreciable degrees, are no longer syrupy like treacle, but have attained to a state of crystallization enabling them to be handled easily. One of these is known as Barbadoes sugar, a very dark sugar. The dark colour, as in the case of treacle, indicates that the 'impurities' are well represented, and that the sugar is very digestible. The same is true to a less extent of Demerara sugar, which, being lighter in colour than Barbados, is to that extent less good. It is, however, very much to be preferred to white loaf sugar.

The only other form of double or complex sugar with which we need be concerned here is beet sugar. The discovery that beetroot and other tubers contain sugar identical with that obtained from the sugar-cane was made in Germany in 1747. It was at first regarded as a matter of purely academic interest, but by degrees its commercial possibilities became apparent, until now beetroot supplies the world with fully two-thirds of the sugar commonly used. Unfortunately, there are no crudities or impurities in beet sugar, and no by-products result from its manufacture from the beet, so that there are no intermediate stages, such as those of treacle and Barbadoes sugar, to record.

When strongly heated, sugar melts into a yellowish liquid, and undergoes certain physical alterations, so that on cooling it does not crystallize, but forms a transparent brittle mass familiar to every one by the name of barley sugar. This is very concentrated. If heated to a still higher temperature its colour darkens, and it acquires a bitter taste; the product being caramel, which is largely used in cooking operations. Sugar candy is merely cane sugar, highly refined, which has been allowed to crystallize round cotton threads. Toffee consists of melted sugar and butter in about equal proportions. When properly made it is a very nutritious substance, containing a fair proportion of the right kind of sugar. Chocolate consists of ground cocoa, from which the fat has not been removed, mixed with highly refined white sugar. The co-called 'cream' found in association with chocolates consists of a combination of two forms of white refined sugar. Jam is made, as a rule, from fruit and refined white cane sugar. The process of manufacture—boiling for a considerable time—has the effect of converting the undesirable white sugar into the more acceptable fruit sugar like that contained in the fruit itself. It is a genuine conversion from a state of sin to a state of grace, and renders jam a highly nutritious and desirable form of food. Home-made jam is usually boiled for a longer period than commercial jam, so that the conversion in the case of the former is more complete. As will be seen later,

however, prolonged boiling certainly destroys some of the vitamins. Inasmuch as these can be obtained from other foods, this drawback is easily countered.

Commercial glucose, made by treating starch with an acid, does not crystallize. It is used by manufacturers to make jam from inferior fruit, or from the residue of fruit from which the juice has been expressed for making syrups and jellies. The product usually has a good appearance, but it is very deficient in flavour and nutritive power.

FATS.

Fats include all the animal fats, such as suet, dripping, lard, bacon-fat, butter, cream, and the fat of egg yolk; together with the vegetable fats, olive oil, cotton-seed oil, nut butters, and margarine; and fish fats, such as cod-liver oil and halibut oil. Suet, which is an animal fat obtained from sheep and oxen, is a common food in cold countries. Lard is melted pig's fat. From the point of view of their content of Vitamin A, which in some circumstances is a very important matter, it is well to recognize that the fats of animal origin, such as cream and butter, egg fat, suet, and cod-liver oil, are superior to the fats of vegetable origin, such as almond oil, olive oil, and cotton-seed oil. Pork fat, however, contains but little of Vitamin A. Fats are necessary in all diets, but the needful amount varies with climatic and other conditions.

MINERAL SALTS.

The importance of the mineral constituents of food may be gauged from the fact that if the supply of these constituents is completely cut off, death ensues within about a month, even though all the other constituents of a normal diet are supplied as before. The above statement, however, comprises most of what is at present known on the subject of our mineral requirements. It has, of course, been established for a long time that calcium, phosphorus, iron, magnesium, sodium, iodine, and other elements are necessary to health, but we have as yet nothing to guide us as to the daily amount of mineral matter which the body demands for the maintenance of its equilibrium. Meat, fish, cereals, vegetables, and fruits are all sources of mineral dietary elements. The mineral salts dissolve in the fluids of our body, and play a vital part in regulating the work of different organs; if certain of these salts are absent from the food, the heart will cease to beat. The red colour of the blood corpuscles is due to iron. Lime salts and phosphorus are essential to the development of bones and teeth in the growing period. Common salt is necessary for the gastric juice. But all these chemicals, and others, some of which are required in very small quantities, are present in any diet which includes a fair variety of natural food-stuffs; so that there is no danger, in well-to-do

civilized life, of any shortage of mineral matter, except in the case of those who foolishly depend to too great an extent upon such articles as white flour and refined sugar.

WATER.

The majority of our food-stuffs contain fluid; some of those from the vegetable kingdom to a degree which is very surprising. Man was at one period of his evolution an amphibious animal, and he still depends in large measure upon water, internally and externally, for the due performance of his physiological functions. Fluid as it presents itself in food is always combined with other material; it already carries all kinds of things in solution and in suspension, so that although it is useful for flushing purposes, it has no value as a solvent. For example, milk is a fluid; but it is so charged with food-stuffs that it is unable to dissolve, say, sugar or common salt. It can suspend these substances, but it cannot dissolve and incorporate them as, say, distilled water is capable of doing. For this reason, though raw fruits and vegetables, by supplying fluid to the tissues, will slake a conscious thirst, they will do nothing to supply the solvent which is necessary for the removal of waste matters from the system. Every one should make a point of drinking from four to six pints of a pure soft water in the twenty-four hours. Tea and coffee are both solvent fluids. Milk-made cocoa is not. It is probable that the cures effected at spas and health resorts are due in an appreciable measure to the large amount of fluid which the patients are made to drink. The exercises and other physical treatment force the waste matters into the circulation, and the fluids dissolve them and flush them out.

So much, then, for what may be called the ponderables in our foods. Before proceeding to consider the vitamins, which are almost imponderable, it is well briefly to recapitulate what has gone before, by reminding ourselves that proteins are represented by lean meat, fish, poultry, cheese, and eggs; that carbohydrates are represented by bread, rice, potatoes, the other cereals, and sugar; that fats and oils are typified by butter and olive oil and nuts; and that mineral salts are found abundantly represented in fresh fruits, salads and vegetables.

VITAMINS.

The conception of disease as caused by the absence of a something in the food instead of by the presence of a microbic or morbific agent—by a minus instead of a plus—seemed very revolutionary to a generation brought up in the belief that Lister and Pasteur, by initiating the science of bacteriology, had solved the riddle of all maladies. And yet the facts had been available for him who runs to read, from the moment at which it was discovered, as far back as the eighteenth century, that

the horrible disease scurvy was due to an absence of fresh fruits and vegetables from the diet. All kinds of theories were advanced to explain the cause, which we now see to be dietetic, of rickets in European children, and of diseases in the East known as beri-beri and pellagra—to say nothing of many vague but disquieting departures from health which seemed beyond the reach of drug therapy. Into this chaotic darkness, Sir Gowland Hopkins shed a most welcome and helpful ray of light by publishing, in 1912, some experiments which he had made, showing that in addition to proteins, carbohydrates, fats, and minerals, there were in food-stuffs some elusive substances, called by him 'accessory food factors,' which were essential to the life and growth of all animals. These substances are now known as the vitamins. Since that time at least six vitamins have been clearly differentiated. No doubt others exist which, when discovered, may be found to be of scientific rather than practical importance. For the sake of simplicity the best-known vitamins are called A, B, C, and D, each one of which is indispensable in its own department. One vitamin cannot deputize for another, as in the case of the food-stuffs proper, where meat can be effectively replaced by cheese, or rice by oatmeal, or olive oil by lard. Vitamin A, for example, cannot replace Vitamin B, and if for a period of three or four months any of these vitamins be not supplied in the food, very serious consequences, and even death, may be the result. It is important to remember that vitamins are present only in very small quantities in any of the food-stuffs, though more in some than in others; that they are very easily removed from foods by the milling of grain, by steeping in water, by cooking—especially for long periods at a moderate temperature—and are completely destroyed by certain chemicals. It has already been said, but it will bear emphasizing, that all vitamins are formed primarily in plants, and that such vitamins as are present in animal tissues are derived from the plants on which these animals have fed. Clearly, therefore, from the vitamin point of view, vegetable foods have a decided advantage over animal foods.

Not many of the individual foods in common use contain all the vitamins. Vitamin A, for example, is found in green vegetables and in all the animal fats except lard. Vitamin B is found principally in the seeds of plants, and in the eggs and internal organs of animals. Vitamin C is present in all fresh fruits and vegetables. Vitamin D is nearly always associated with Vitamin A in animal fats. Cod-liver oil and halibut-liver oil are especially rich in both Vitamin A and Vitamin D.

The best fruits for the easy supply of Vitamin C are oranges, lemons, tomatoes, pineapples, strawberries, apples, and bananas—in that order. Curiously enough, grapes are almost useless from this particular point of view. The vegetables which hold this vitamin in greatest abundance are watercress, spinach, cabbage, green peas, cucumber, and carrot.

All these may be eaten raw as well as cooked. Cooking, though it does not in every case destroy vitamins, is very liable to interfere with them.

Milk and its Derivatives

Most of the ordinary foods contain the foregoing proximate principles, proteins, carbohydrates, fats, salts, and vitamins, in various proportions. In some foods there is a very large preponderance of one element over the others; meats, for example, consist so largely of protein that there is a consequent shortage of the other elements so serious as to render an exclusive meat diet quite unsuitable for prolonged use. It is the same with the other foods; potatoes, for example, contain little else than starch. The only form of ordinary food which is scientifically complete is milk. There are of course several kinds of milk—cow's milk, human milk, goat's milk, etc., and several categories of cow's milk—but in all of them the proximate principles are represented sufficiently to maintain life and promote growth over long periods of time. When it is realized that for the first year or so of life milk is practically the only food of a human infant, the importance and sufficiency of this form of nourishment is obvious.

COMPOSITION OF MILK.

The *Protein* in milk, which constitutes about 3% of its total weight, is present in the form of what is usually known as casein. Roughly speaking, it is that part of the milk which supplies the curd and the solids which go to the formation of cheese. Casein has some very special advantages over every other form of animal protein. Important is its power of neutralizing acid in the stomach; whilst another advantage lies in the fact that it contains the all-essential element phosphorus in a particularly digestible form. Casein is exceptionally easy of digestion and absorption.

The *Carbohydrate* constituent of milk is milk sugar, or lactose, which is present to the extent of about 5%. Lactose differs in many ways from every other form of sugar, but in nothing more than in its almost complete freedom from sweetness of taste. This is a valuable quality, because sweetness so easily palls. Milk sugar is not capable of being fermented by yeast. This substance, though chemically a sugar, is thus lacking in the two most conspicuous characters of the substances usually known by this name: it is nevertheless a full member of the great carbohydrate family, and, as taken in milk, it affords an excellent example of the dietetic efficacy of a sugar which is neither concentrated nor refined.

The *Fat* of milk contributes about 4% to the total weight. It is

important to remember that the amount of fat in the different kinds of milk varies with the type of animal which secretes it; when the climatic conditions demand much fat, the animal's milk supplies it. The milk of the whale, for example, contains no less than 43%, as against a maximum of 5% in the milk of cows living in the temperate zone. Fat, is present itself in milk in the form of an emulsion or mixture of quite wonderful fineness. It is calculated that in one drop of milk no larger than a pin's head, there are no less than a million and a half of separate fat globules. Oil which is so finely subdivided is necessarily very easy to digest. When milk is allowed to stand, these oil globules run together and float on the surface as a separate and distinct layer—the cream.

It is, however, a mistake, often made, to speak of cream as consisting of pure fat, for it contains a large proportion both of casein and milk sugar. Indeed it may be said that cream is merely milk which has lost a large proportion of its water. It should contain 40 to 50% of butter-fat, together with 2·5 % of casein, 4·5 % of milk sugar, and 0·5 % salts. Devonshire or Cornish, or clotted, cream is prepared by heating the milk in deep pans, which causes a rapid and very complete separation of the fat. The proportion of oil in such cream is nearly 60%. The cream thus prepared contains only about half the amount of sugar present in ordinary cream; a fact made use of in the dieting of diabetics.

One of the principal uses of cream is in the production of butter, which is effected by churning. The churning causes all the fat globules in the cream to run together into a solid yellow mass. The casein, milk sugar, and salts remain behind in the fluid, which is then known as buttermilk. This is very cheap and very nutritious, and although it has a peculiar sour flavour, children soon acquire a taste for it.

Water is the only remaining constituent of milk to claim attention. It is surprising to find that such a nutritious fluid contains no less than 87 to 88 % of water; yet such is the fact. And it is curious to note that for an ordinary healthy person milk is not a *fluid* food; it solidifies into clots or curds as soon as it enters the stomach.

COMPOSITION OF CHEESE.

A derivative of milk which plays an important part in human dietary in all countries is cheese. Cheese consists of the casein and the fat of milk, and the differences between the various kinds of cheeses are largely due to the relative quantities of these two main constituents. In the hard cheeses, such as Cheshire, Cheddar, Roquefort, and Caerphilly, most of the fluid is squeezed out of the mass, whereas in the soft cheeses, such as Camembert, Gorgonzola, Limburg, and Stilton, a fair amount of it is allowed to remain.

It is often said of cheese in general that it is difficult of digestion.

Such truth as there may be in this statement is due to the large amount of relatively insoluble fatty matters which all cheeses contain. The fat forms, so to speak, a waterproof coating which protects the mass from the action of the gastric juices. If, however, the cheese is thoroughly broken up by mastication, this objection does not hold; and, as a hard substance is more likely to be thoroughly chewed than a soft, the hard cheeses are less open to the charge of indigestibility. There is, however, no reason why cheese should not be grated (as in dishes *au gratin*) or otherwise subdivided before it is eaten or cooked. In the case of those who find a real difficulty in digesting cheese, a little ingenuity in breaking it up and combining it with other substances, either cooked or uncooked, should certainly be exercised, because, if it can be digested, cheese is by far the best available substitute for meat and flesh foods. The high nutritive value of cheese is generally appreciated; scientifically it may be expressed by saying that 'a pound of Cheddar cheese represents the casein and fat in a gallon of milk,' and that 'beef contains less than half as much nourishment as the same weight of cheese.'

CONTAMINATION OF MILK.

Before leaving the subject of milk and its derivatives, it is well to consider the one serious drawback to milk as a food, namely, its admitted liability to contamination. This is a very serious question, which has engaged, and is still engaging, the attention of those who are interested in the public health. There are two schools of thought in the matter. One of them seeks a method of so treating milk as to render it completely free from dirt and micro-organisms in general, and from the bacillus of tubercle in particular. The other holds the view that, while the general cleanliness of milk is essential, and while all reasonable care should be exercised in transporting it, the ideal of a bacillus-free milk is practically impossible of attainment; and, that even if such an ideal were realizable, it would not be advisable. The abolition of micro-organisms, they urge, would mean the disappearance not only of our bacterial enemies, which are after all not many, but also of our bacterial friends, which are numerous and important. It is certain that some of our digestive processes are aided by friendly bacteria, and it is probable that other physiological happenings gain from this kind of extraneous assistance. It has, moreover, been argued that an over-scrupulous regard for complete freedom from bacteria would deprive milk of its valuable immunizing power. By this is meant the power possessed by small and relatively harmless doses of a poison, continually administered, to mobilize the defensive resources of the individual, so that he gradually becomes impervious even to mass attacks. Modern knowledge of immunization would, indeed, suggest

that minute doses of tubercle in milk may have some effect in 'hardening' children against the evil influence of underfeeding and insanitary conditions. Every one must agree that it is highly desirable that the community should be supplied with clean, wholesome milk, in the same way as it ought to be—and for the most part is—supplied with uncontaminated water.

It is, of course, very easy for dishonest people to dilute milk, and if the water used for such dilution is polluted, the results are such as to defeat the most stringent measures for securing purity at the source. Milk is sometimes diluted with pure water, and its specific gravity thus reduced. But, for reasons into which it is unnecessary to enter here, the specific gravity test is recognized as unreliable. The whole quality of a specimen of milk may, however, be simply and summarily gauged by estimating the quantity of contained fat or cream. A milk which is rich in cream is also rich in protein, carbohydrates, and salts; a 'thin' milk, containing but little cream, is always poor in the other constituents. Commercially, too, there is sufficient reason for accepting the amount of fat as the standard of the money value of a milk, for the reason that the fat of milk (cream) is its most expensive constituent.

DIGESTION OF MILK.

Milk being thus a very complete and, in a sense, a very concentrated food, discretion should be exercised in adding it to other foods. It may be diluted with water or soda-water, or it may be so treated as to prevent its forming a solid clot in the stomach as, especially in acid stomachs, it has a tendency to do. Probably the best way to prevent this is to add a small quantity of citrate of soda (as much as will lie on a sixpence), previously dissolved in a teaspoonful of water, to each tumblerful of diluted milk.

EGGS

After milk the nearest approach in nature to a scientific ideal food in a small compass is the hen's egg. Inasmuch, however, as an egg is almost completely devoid of carbohydrate, it is far from being a complete food; and owing to the fact that eggs are nearly always eaten cooked, they must, to that extent, be regarded as deficient in vitamins. They furnish us, nevertheless, with a very remarkable food of fairly regular composition, and particularly rich in the mineral salts upon whose presence so much depends in our growing period. There appears to be no difference in composition between eggs with dark shells and those with white shells. The former are preferred by the British public, but merely on 'artistic' grounds. Americans, on the same grounds, prefer white eggs. The composition of an ordinary egg is approximately as

follows: shell, 11·2%; water, 65·5%; protein, 13·1%; fat, 9·3%. In the matter of digestibility it is to be noted as a matter of curiosity that a lightly boiled egg is more quickly disposed of by the stomach than a raw egg; but eggs, however taken, whether cooked or raw, are generally very well and quickly digested. Nevertheless, among the articles of food to which some unfortunate people display a violent physiological antipathy, eggs take a high place. Some people with this idiosyncrasy are unable to swallow even a small particle of egg without becoming violently and alarmingly ill. The symptoms in slighter cases, though not so alarming, are definite and very unpleasant. Among such are urticaria, vomiting, attacks of asthma, and other manifestations which are not usually associated by the lay public with dietetic peculiarities. The portion of the egg usually responsible for these troubles is found to be the white.

There is not much difference in composition between a hen's egg and a duck's egg. Duck's eggs are somewhat larger, but many cooks do not like them, saying that they cook badly, are difficult to omelet or scramble, and mix badly with hen's eggs. Many people, again, object to duck's eggs on the ground that they have an unpleasant taste and smell; though the eggs of the Indian runner and its relations are almost free from these. It is certainly true that in comparison with hens, ducks are dirty feeders, and this fact may partly explain the widespread prejudice against their eggs. Turkey's eggs and guinea-fowl's eggs are not open to these objections.

Other Animal Protein

MEAT, POULTRY, ETC.

Of the other foods derived from the animal kingdom, by far the most important is meat or flesh; that is, muscle. It is convenient to divide flesh foods into butcher's meat, poultry, and fish. Butcher's meat consists almost entirely of protein, together with some fat and much water. Mutton contains more fat than beef, pork more fat than mutton, and bacon no less than 60% of fat. None of the butcher's meat foods contains an appreciable amount of carbohydrate. As to the relative digestibility of the various kinds of meat, it is a general rule that the digestibility varies inversely as the fatty content. There is a popular belief, which seems to be very ill-founded, that mutton is particularly digestible. Inasmuch as mutton fat, especially when hot, often proves irritating to the stomach, action based on this fallacy may easily give rise to digestive difficulties. It is often said that cooking renders meat foods more digestible. There would seem to be some fallacy in this, for all physicians agree that raw or, at all events, very underdone meat is a form of food which

patients with weak stomachs can digest more easily than most other forms of nourishment. It takes us back to primitive man, who hunted his game and ate it raw. As bearing upon this point, it is interesting to find that the flesh of hunted animals is highly prized for its taste, on account of the acid fatigue-products which the muscles contain. It is to produce the same gustatory effect that some gourmets have their flesh foods soaked in vinegar before cooking.

Poultry contains much the same percentage of protein as lean beef (20%), but more fat; 8% in young chicken, rising to 20% in turkey, 26% in duck, and 31% in goose. The breast of chicken and game is probably the most digestible form of flesh food. The legs, on the other hand, are often very tough. Very fat duck and goose should be avoided by those with delicate digestions; the fat of such birds, in conformity with the general rule, renders the muscle difficult of access to the digestive juices.

Certain of the animal organs (known colloquially as 'offal') have definite qualities which justify their differentiation from the main carcass of the animal and from one another. The liver and kidneys resemble each other physically in being compact and homogeneous organs, consisting almost entirely of protein, with a small part of fat. Liver especially is a very good and relatively inexpensive form of protein food. 'Sweetbread' is a name given to both the thymus gland and the pancreas of the animal. In either case it is a very easily digested form of protein. Tripe is the name applied to the stomach and intestines of the ox after being cleaned and boiled. It contains fat, as well as protein, but is nevertheless very digestible. It is unfortunately rather insipid, which is presumably the reason why it is usually served with onions. Perhaps the most surprising thing about these flesh foods, which are usually regarded as solids, is the high proportion of water which they contain. Thus, lean beef contains 76·5% of water; lean mutton, 75%; hare, 74%; rabbit, 66%; fowl, 70%. When flesh foods are cooked, even when they are boiled, they lose an appreciable amount of their water, together with a certain amount of fat and some of the mineral salts.

GELATINE.

The substance known as gelatine has occupied a place of some importance in dietetics. Gelatine is a stiff elastic material obtained by boiling solid and semi-solid parts, such as bone and cartilage. Its distinguishing characteristic is that of dissolving in hot fluids and forming a jelly on cooling. When pure it is colourless, transparent, and almost tasteless. Its purest form is isinglass, made from the air-bladders of fishes. Glue and size are impure forms of it. It is used for making all kinds of jellies, and for the manufacture of photographic

plates, and explosives. The skeletal portions of young animals are particularly rich in gelatine; calves' feet, for example, have long been known as abundant yielders of jelly.

From the point of view of nutrition, gelatine is now regarded as a para-protein, which is defective in certain important constituents of real protein, and cannot therefore be regarded as a substitute for, say, meat or cheese. As an adjunct to other forms of protein, however, it is of considerable value. It has the great merit of fixing and neutralizing acids in the stomach, and may therefore usefully be added to ordinary foods in cases of acid dyspepsia.

FISH.

Fish is a form of protein food which is usually believed to be exceptionally digestible, and it is a matter of everyday experience that delicate stomachs are able to deal with the lighter and whiter fish more easily than with almost any other form of protein. Fish resembles meat in consisting almost entirely of protein and fat. The amount of fat varies very much. For purposes of classification fishes are divided into three groups: (*a*) Those with more than 5% of fat, including eel with 18%; salmon, 12%; turbot, 12%; herring, 8%. (*b*) Those with 2 to 5% of fat, such as halibut with 2 and up to even 10%; mackerel, 2 to 9%; mullet, 2½%. (*c*) Those with less than 2%, among which are cod, haddock, and whiting.

In estimating the physiological and commercial value of fish as a food one has to remember the very large amount of useless matter in the form of skin and bones which most fishes contain. This may amount to as much as 70% of the fish as sold to the consumer, and may be quite 35%, even when served at table. The protein in fish contains more gelatine than does the protein in meat. Fish, then, with all its merits, is not altogether an economical form of protein food, though the cheaper varieties of fishes offer a considerable amount of nutriment for a small sum. Indeed, one authority maintains that the underrated herring 'offers the largest amount of nutriment for a given sum of any animal food, two herrings containing as much animal protein as need enter the daily dietary of an ordinary working man.'

It used to be thought that fish has some special value as a brain food, so that thinkers, politicians, and the clergy were urged to consume it. As a matter of scientific fact there is no foundation whatever for this opinion. It was founded on the supposition that phosphorus is necessary to thought, and that fish contain a lot of that element.

Shell Fish are very popular in this country as delicacies. Both lobster and crab (their composition is practically the same) have flesh which is dense and coarse, and very indigestible. Crab and lobster, though crab less than lobster, have a tendency to contain irritants, and even

active poisons, in their flesh; they should therefore be eaten with great caution, even when quite fresh. Oysters are a very acceptable form of food to most people. When taken raw they are easily digested, but their value as nutriment is not high. The great objection to oysters is their liability to harbour the germs of typhoid fever in a peculiarly virulent form. When thoroughly cooked, however, their dangerousness disappears. English oysters are as a rule moderately safe if taken raw, but it is never wise to eat them outside the British Isles. Mussels are even more to be suspected than oysters. The wise will eschew them; especially in France.

MEAT EXTRACTS.

Medical writers have for long exposed the fallacy that beef-tea and meat extracts generally are nutritious. Soups may, of course, be rendered nutritious by the addition of vegetable and other valuable ingredients, as with pea-soup and soups containing milk and its derivatives; but the ordinary beef-tea or clear soup is little more than an agreeable stimulant.

Vegetable Foods

So much, then, for the food-stuffs which derive from the animal kingdom; the chief characteristics of which, excluding milk, we have seen to be density of substance with richness in protein and fat, associated with relative poverty in carbohydrate. In the vegetable kingdom, which we are about to consider, we find the contrary characteristics, namely, compressibility associated with richness in carbohydrate and relative poverty in protein. The most striking feature in the composition of vegetable food-stuffs is the large quantity of water which they contain. In the case of green vegetables and most fruits, water accounts for more than 90% of the food in its fresh state. This means that a cabbage is really a more watery form of food than milk, which contains but 87% of water. Turnips contain 90% of water; carrots, 86·5%; tomatoes, 91%; watercress, 93%; and cucumber, 95%. In this matter fruits are even more surprising; thus we find a strawberry to contain 89% of water, with only 5% carbohydrate; an apple 82% water; a peach 88%; an orange 86%; and a lemon 89%.

It will thus be seen that the food-stuffs with which Nature presents us are all very dilute. Even milk, which, inasmuch as it contains all the ingredients of a perfect diet, may be regarded as concentrated food, contains nevertheless as much as 87% of water. Attempts are constantly being made to counteract this element of dilution in foods with the object of reducing their bulk. These attempts have not so far

been very successful; and this is fortunate, because their bulkiness or dilution is a great bulwark against over-eating. It is all too easy to over-eat on concentrated stimulating foods, such as roast beef and pickles, but it is almost impossible to over-eat on green vegetables and fruits, even when these are reinforced by bread, butter, cheese, and beer.

CEREALS, BREAD, ETC.

In the vegetable kingdom the most important class, dietetically, is that of the cereals, because it is from them that bread is derived. The cereals include wheat, oats, maize, and rice, all of which conform to the standards of a complete food in the sense that the proximate principles of proteins, carbohydrates, fats, and salts are fairly well represented in each of them. The carbohydrate content in the form of starch is, however, in each case in considerable excess. They are complete, but unbalanced, as may be seen clearly in the following table:

	Water	*Protein*	*Fat*	*Carbo-hydrate*	*Mineral*
	%	%	%	%	%
WHEAT .	12	11	1·7	71·2	1·9
OATS .	10	10·9	4·5	59·1	3·5
MAIZE .	12·5	9·7	5·4	68·9	1·8
RICE .	12	7·2	2·0	76·0	1·0

Of these, in civilized countries, wheat is by far the most important, because it is from wheaten flour that bread, 'the staff of life,' is produced. Next in importance to British people, especially in the north of England and Scotland, come oats, because of the large amount of oatmeal there consumed in the form of porridge and scones. Rice, though a favourite food, especially in the East, is of relatively poor nutritive value. It is, however, very easy of digestion. Maize is little used in England as human food, but in America it forms a staple article of diet; and, since the potato famine in Ireland in 1848, it is much used in that distressful country, chiefly in the form of a sort of porridge known as stirabout.

As has been said, by far the most important food which is made from wheat is bread. Unleavened bread is made of wheaten flour mixed with water and salt, and then baked. It is not much used in this country because it is extremely hard, but among some races it is the main article of diet. Leavened bread is bread which has been rendered light and spongy by the action of gas, mainly carbonic acid gas, produced within it by the fermentation of yeast or by chemical action. The yeast generally used in the making of bread is a living plant which, when allowed to grow on a suitable soil, such as sugar, multiplies rapidly.

In the process of its growth it splits up the sugar into alcohol and carbonic acid, and it is the latter substance which confers upon bread its lightness and sponginess.

The process of bread-making varies much in different parts of the country. The usual proportion is three-quarters of a pound of flour to a quarter of a pint of water. Aerated bread is made without yeast; it owes its lightness to the presence of carbonic acid gas which is prepared separately and forced under pressure into the dough. There is consequently no fermentation process, and no danger of the bread becoming 'sour,' as it is called.

Baking powders are much used in the baking of bread and cakes. They consist of chemical substances which, when moistened with water, give off carbonic acid gas. They are mixed with flour and the other ingredients, so that the liberated gas may permeate the dough and confer upon it the required sponginess.

'Fancy' breads are usually made from pure wheat flour. Milk is often used to mix with the flour instead of water; thus adding to the nutritive value of the bread. Ordinary white bread is made from baker's flour; 'household bread' is made from standard flour, which is cream coloured. Wholemeal bread or brown bread contains all the component parts of the white, with the addition of the bran. For this reason brown bread is richer in minerals and fat than is white bread.

A good deal of controversy has raged around the respective merits of white bread and brown bread. There was at one time a strong prejudice in favour of white bread, but it is now generally realized that brown bread is more economical, inasmuch as it contains more protein and minerals, and is richer in vitamins than white bread. This no doubt is a very important matter to those who depend largely upon bread for their sustenance, and for growing children; but for the majority of well-to-do people there is very little advantage in brown bread over white except that brown bread supplies more roughage, and is, therefore, better for those who are troubled with constipation. Many people, too, prefer the flavour of brown bread.

Bread is one of the most nutritious of all food-stuffs; but, although it contains most of the essential constituents of food, it is by no means a complete diet in itself. It is notably deficient in protein and fat, which supplies the reason for the practice, almost universal among civilized people, of supplementing bread with butter, cheese, and other milk derivatives.

Of other wheat preparations, the best known are semolina, macaroni, and vermicelli. When added to any of the fat-forming foods, such as milk, eggs, or cheese, and well cooked, they make very acceptable articles of diet.

The various biscuits are made of a mixture of flour and water, and

consist largely of carbohydrates. Some varieties contain sugar, butter, and flavouring substances. Some are lightened by the use of baking powder. Those which consist of wholemeal contain a larger quantity of protein than do the ordinary variety made of white flour. Biscuits are thoroughly well baked, and thus contain very little water. They are nutritious and digestible, probably because their hardness and dryness compels them to be well masticated in the mouth, and thus completely mixed with saliva.

Rusks are made of wheaten dough, to which sugar, butter, and milk are added. They are baked twice and then dried.

Oats, which are much used in some parts of the country, notably in Scotland, Ireland, and Wales, in the form of porridge and oatcakes, usually contain a greater amount of nutritious material than any other cereal. The outer covering or husk consists almost entirely of indigestible cellulose, and is firmly attached to the kernel so that its complete removal is not an easy matter. In the process of grinding, particles of cellulose are left in the meal, which is consequently more stimulating to the intestines than is wheatmeal. Some people complain that oatmeal is too 'heating' for them. There certainly seems to be some ground for this complaint, for skin eruptions of various kinds are found to follow its use by predisposed people at certain times of the year. It is said that oatmeal is one of the few vegetable foods which contain appreciable amounts of purin bodies, which are often supposed to be the cause of gout; but there is probably a good deal of exaggeration in this statement. Oatmeal was, until recently, obtained altogether by grinding. Recently, however, rolling has been introduced into its preparation. The great pressure to which the grains are subjected by this new process flattens the grains out, so that they are more easily softened by cooking.

Groats are oats from which the husk has been entirely removed.

Maize or Indian corn is not very much used in England. It is, however, as has been said, the staple diet of South America, and is much used in the United States, South Africa, and Ireland. In the preparation of corn-meal the germ and husk are removed, and the grain is ground to various degrees of fineness. The meal is then used in the form of porridge and otherwise. The so-called johnny-cakes of the United States are made of unleavened, coarse corn-meal, and resemble the *tortillas* of South America.

Hominy is maize which has been split and broken into fragments. It is made into puddings or porridge.

Cornflour consists almost entirely of carbohydrates in the form of starch. It is prepared from maize by a process of washing, in which the starch is separated from the protein and fat.

Maize is a food of great nutritive value. An American writer says

that with a diet of little else but maize, bread, and pork, the workmen of many of the United States are capable of enduring the greatest fatigue, and performing an enormous amount of physical labour.

Barley is not much used nowadays as an article of diet. Barley-meal was formerly the chief means of sustenance amongst the labouring classes in England, but it has in late years been almost entirely replaced by wheat and its preparations. 'Pearl barley' and 'patent barley' are the two forms in which it is now taken. Pearl barley consists of the kernel only, the husk being removed. The 'patent' variety is made by grinding the kernel into flour. Barley is used in soups and in making barley-water.

Rye is very much used in Northern Europe, especially by the Germans. Rye bread is moist, heavy, and very dark in colour. It is digestible, but, to most British tastes, not very palatable.

Rice is rich in starch, but poor in protein and fat. It is very digestible and well absorbed, leaving a very small amount of residue. In this country it is chiefly used for puddings, and is supplemented with milk, eggs, and cheese. In India and other parts of the East, millions of people live almost exclusively upon it, accompanied by various sauces and condiments. It is often combined with food made from other members of the vegetable kingdom which are richer in protein and fat. Polished rice is the grain which has been divested of the grey-coloured skin which normally envelopes the endosperm. This polished rice, though whiter and of 'better appearance,' is of much less value as a food-stuff; the unpolished variety should always be chosen.

Tapioca and sago are starchy foods which to some extent take the place of cereals. Tapioca is made from the root of a South American plant, and is prepared by washing the grated root and collecting the starch which has settled in the washings. It is dried on hot plates, and in the process most of the grains are ruptured. Sago is made from the pith of the sago palm. It also consists mainly of starch, and resembles tapioca in its properties.

PULSES.

Next in importance to the cereals come the pulses, namely, peas, beans, and lentils. They are relatively rich in protein and carbohydrate, but poor in fat. This supplies the reason for their association with bacon and olive oil in ordinary dishes. They are said to be rather indigestible even when thoroughly cooked—an altogether undeserved reputation. When quite young they are digestible even raw, but all too rarely, their delicacy is wasted through being left until they are hard and harsh. Green peas contain about 15% of carbohydrate. They are best cooked by steaming. Beans are of many kinds. When green, French or kidney beans are eaten with the pod.

They may be eaten raw, but when old and stringy they require in that case very thorough mastication. Broad beans are too much neglected in this country. They are very nutritious, and when properly prepared by cooking are very digestible. They contain no less than 25 to 50% of carbohydrates.

ROOTS AND TUBERS.

Roots and tubers, which are laid under contribution for human food, may be regarded as reserves of nourishment intended for the use of the adult plant, just as seeds are reserves for the infant plant. During the spacious days of spring and early summer the plant lays by what it does not require, so that it can utilize the store later on; and this store usually consists mainly of starch. There is also a certain content of protein and fat, but relatively little. Of the tubers the most important is the potato. This was introduced into England about three hundred years ago, and since that time has steadily increased in popular favour, until it is now one of the most valuable of our staple articles of diet. This is especially true of Ireland. The starch grain is of a specially large size, and the tuber is used in commerce because of its richness in this factor. The digestibility of potatoes depends largely upon the manner in which they are cooked. A floury potato is more digestible than a waxy potato, and mashed potatoes are more easily digestible than are potatoes which are fried in fat. A boiled potato takes two to two and a half hours for its thorough digestion. Young potatoes require a great deal of mastication for their thorough digestion. Potatoes are unsuitable for use as the only means of nourishment, and should be supplemented by foods which contain protein and fat. The practice in Ireland of using as supplemental matter buttermilk and herrings is dietetically perfectly sound. The most important mineral ingredients in potatoes are the salts of potash, and potatoes are one of the chief sources from which we obtain our supply of these necessary salts. The ordinary potato contains 78·5% of water and 18% of starch. Its salts make up nearly the whole of the remaining 3½%.

The next most important root is the turnip. This consists largely of water, with a small amount of carbohydrate in the form of pectin—a jelly-forming substance—and a certain amount of mineral salts. It contains no less than 90·3% of water. It is almost incredible that a root which seems so firm and uncompromising as a turnip should contain so little solid matter. Its carbohydrate content is only 5%, and its protein content under 1%. The carbohydrate in the turnip is not in the form of starch. In view of these facts it is obvious that the turnip can never be regarded as an important source of nutriment.

The carrot is a much more interesting root than the turnip. It is by far the more nutritious of the two, owing to its richness in sugar—

nearly 10%, mostly in the form of fruit sugar. It does not contain much protein, but its mineral salts, which are present mainly as potash, are of considerable value. A carrot when young is very digestible, even eaten raw. It contains 86·5% of water. Young carrots constitute a very good form of food, if it is remembered that they contain only a very small proportion of protein, and so need supplementing.

Beetroot is a valuable food-stuff in the same way as the carrot is, namely, owing to the large amount of sugar it contains.

Parsnips come into the same category as carrots. They are fairly rich in starch and sugar, but lose a good deal in the process of cooking.

Jerusalem artichokes resemble turnips in containing no starch. They contain a little sugar and about 2% of a peculiar carbohydrate, inulin, about which little known.

The onion has a high value as a flavouring agent; though its nutrition value is not great.

It used to be thought that roots and tubers were of less value than other foods because they had not been exposed to the influence of the sun's rays. This is now known to be a mistaken view. Most of them contain vitamins which follow the usual rule of being either destroyed or profoundly modified by prolonged boiling or cooking.

GREEN VEGETABLES.

We now come to the vegetables which are grown above ground. Green vegetables consist chiefly of water, with a very small amount of protein and carbohydrate. Their dietetic value is due to the facts that they are rich in minerals, especially in potassium and iron, and that they are a very important source of vitamins.

A cabbage, for example, contains 89·6% of water, 5·8% of carbohydrates, and 1% of protein. From this it will be seen that the amount of solid nourishment in a cabbage is very small. The effect of cooking upon green vegetables is still further to reduce their already poor stock of nutriment; for by cooking they gain water and lose part of their carbohydrate and protein, and a good deal of their mineral matter. For example, the cabbage loses by boiling 30% of its total solids, this percentage being made up of about half of the total mineral matter, one-third of the carbohydrates, and 5% of the protein.

Cauliflower is a useful and attractive form of vegetable. It is very easily digested. The green tops of turnips and other root vegetables should not be thrown away, but should be utilized for cooking in the same way as cabbages.

Spinach is one of the most useful of all vegetables.

Endive, lettuce, mustard and cress, and other green vegetables used in salads, and eaten in the raw state, are valuable on account of their vitamin content.

Tomatoes consist chiefly of water, with a certain amount of carbohydrate. It used to be thought that they contained oxalic acid in undesirable quantities, but this is now known not to be the case, and gouty people may eat them with impunity. They are very easily digested, and are a valuable source of vitamins.

Mushrooms, contrary to the popular idea, are not very nutritious. They contain, in addition to water, a certain proportion of cellulose, a little nitrogenous matter, sugar, salts, and various substances to which they owe their flavour.

FRUITS.

Fruits are, in this country, eaten because of their refreshing qualities and their pleasant flavour, rather than for any great nutritive value which they may be thought to possess. Most fruits consist of a very large percentage of water. The strawberry, for example, contains 89%; the apple, 82%; the peach, 88%; the greengage, 80%; the gooseberry, 86%; the blackberry, 88%; the water-melon, 92%; and the lemon, 89%. It is curious that grapes, which one would expect to have a large fluid content, have only 79%. Bananas have but 74%.

Much of the nutritive and stimulating value of fruits is said to reside in their skins, and people who are convinced fruitarians always eat their fruit as Nature has presented it to us. According to their view the practice of peeling fruit is undesirable. Bought fruits should, however, be carefully wiped before eating. The most nutritious fruits, bananas, figs, dates, and raisins, are not indigenous in this country. Bananas contain both carbohydrates and protein, and may therefore be regarded as a complete food, and many native races subsist on them almost entirely. Figs contain a large quantity of sugar, and a certain amount of protein. They are nutritious, and are said to compare in this respect favourably with an equal weight of bread. Dates are rich in sugar, and are the chief article of diet in Egypt. Raisins are, of course, dried grapes. They contain a certain amount of sugar, with a little protein and vegetable acids and salts. They are a very good form of food. Almonds and raisins, in right proportion, do indeed furnish an almost complete theoretic human dietary.

NUTS.

Nuts, unlike most of the juicy fruits, constitute something very near to a complete food. Bulk for bulk, they are said to be amongst the most nutritive foods which we possess. They contain 15 to 20% of protein, 50 to 60% of fat, 9 to 10% of carbohydrate, 1% of mineral matter, and 5% of water. Owing to their richness in fat, nuts are said

to be indigestible, but this they need not be if they are properly masticated before they are swallowed.

The chestnut has been held to be the most valuable of all the nuts from the point of view of diet. This is on account of its containing a high proportion of carbohydrates along with protein and fat. There is a saying that if you give a Sicilian a goat and a chestnut tree he will do no more work all his life.

Dietetic Principles

In order to enable the reader to take an intelligent interest in the scientific side of dietetics it has been thought desirable to enter into some slight detail regarding the chemistry of food values: it should, however, be clearly understood that a healthy person should not concern himself too minutely about such matters as the composition of his food in proteins, calories, vitamins, etc. When a rational dietary, in consonance with a person's personal and physiological predilections, has been decided upon, it should, as a matter of routine, be adhered to. But there ought in any case to be plenty of variety in this routine scheme, and a definite departure therefrom, every now and then, is not only harmless, but positively beneficial. Such departures may be either in the direction of fasting or of full eating. People like to celebrate great occasions by plethoric banquets; and such banquets — and this includes Christmas dinners — have a certain scientific sanction. Provided that it is not too frequent, feasting is useful in keeping the digestive organs in training, as it were. It prevents these organs from getting into a groove in which they might incline to become priggish and reject anything which was unusual. The trouble, no doubt, is that the occasional feast seems to do so much good in raising, not only the tone of the digestive organs, but the general morale, that the individual is likely to conclude that feasting should be his rule and moderation his exception. And, just as occasional—very occasional—feasting does good, so does occasional fasting.

FASTING.

Fasting is by no means a popular hygienic measure, but it is a very efficacious one. The notion that strength must be kept up at all hazards, and that this can only be effected by grim and conscientious over-feeding, is so firmly fixed in the popular mind that any suggestion of fasting is received with derision. And yet it is the simplest and cheapest and least dangerous method of redressing a digestive balance that could be imagined.

The method of going about a fast is not the simple one of abstaining

from food for the prescribed time; it requires a little preparation and a little management. It is fully described in a later section, but a short synopsis may be appropriate here. It is important so to arrange matters that the intestines, especially the large bowel, should be empty before the fast begins. This is best ensured by taking a dose of Epsom salts or Glauber's salts, or any other simple aperient, such as castor oil. When the bowels have acted thoroughly, thus preventing any risk of the reabsorption of effete matters, the fast begins. Assuming that it is to last three days, the patient must make up his mind to take nothing except water (containing perhaps Epsom salts or bicarbonate of soda) for the prescribed period. If he yields to the persuasion of his wife to try a little beef-tea (to keep up his strength) he will be punished by a craving for food; whereas, if he takes nothing, the slight desire for food at the usual meal-times on the first day very soon passes off. The desire on the second day is definitely less, and on the third day the desire has almost disappeared. Except for somnolence, which is often a prominent feature, especially at the usual meal-times, the patient feels much as normal, except that his brain is more active. If he is very sorry for himself he can remain in bed, and may derive comfort from hot baths and gentle massage, but as a rule there is no reason why he should not follow his usual vocation. If he does this he is the more likely to find his discipline tolerable. The fast should be broken at its end by a very small meal, such as a lightly boiled egg and some thin bread and butter. Fasts of this kind are very useful to people whose work compels them to eat more than they really wish to do, and very much more than they require. It is not, of course, always necessary to fast for three days. Fasts of lesser duration will frequently restore a digestive balance to normal; but whatever the duration, whether more than three days or less, the technique above described should be carefully observed. People who are afraid to undertake a fast lest something terrible should befall them, should accustom themselves to the theory and practice by missing a meal every now and again. They will then be able to convince themselves that fasting is not only perfectly safe, but is in a sense rather an agreeable discipline giving what the Americans call an uplift. The best meal to miss for this trial purpose is certainly the midday meal. The result of this 'missing' in some cases has been the total abolition of luncheon, a change the success of which, in the preservation of energy, has surprised many.

INDIGESTION AND OBESITY.

It cannot be too frequently repeated that the act of ingestion, the conversion of crude food-stuffs into material capable of digestion, the digestive acts, and the ultimate absorption into the blood-stream, make up a highly complicated series of processes which demands for its

successful performance an enormous amount of energy; hence the habit of the 'siesta' in some countries, and hence the heaviness and drowsiness of those who eat largely and do not abandon themselves to a siesta. The blood which is wanted in the brain is otherwise occupied. It is engaged upon the physiologically more important task of the disposal of food. It is frequently said that most people eat too much. This is largely true of sedentary folks, who often eat, day after day, an amount of stimulating meat and saccharine food which would more than suffice for a man doing hard physical labour during eight strenuous hours daily. The most common result of this over-eating, both in quantity and quality (it is the quality which is responsible for the quantity; no fruitarian over-eats), is indigestion in some form. In comparatively healthy people, while still young, indigestion is liable to assume forms which are slight in degree and difficult of recognition, so that the over-eating continues until it shows itself in middle life in the form of obesity. Here it is necessary to say in parenthesis that not all forms of obesity are due to over-eating. Most cases of corpulence are certainly caused by over-indulgence in the pleasures of the table, but there are some instances which are due entirely to the defective action of some of the endocrine glands, notably the thyroid, the pituitary, and the ovaries. Examples of obesity due to such causes may be observed in women at the change of life.

When obesity is due to dietetic causes the fault not infrequently lies, as has been said, not so much in excess in quantity as unsuitability in quality, though in many cases the two are combined. It is always well in the first instance to reduce the gross intake. If, for example, afternoon tea with scones and cake and other starchy and saccharine material is taken, then that meal should be deleted from the schedule. It is well to inquire further as to what may be called illicit intakes, such, for example, as chocolates and other sweets between meals. It is astonishing to find how many sensible educated people will, while adhering more or less closely to a slimming diet so far as regular meals are concerned, nevertheless eat large quantities of chocolates and lollipops between meals, on the plea that these are not on the list of things forbidden.

The various diets which have been recommended for corpulence, from Banting's down to the present day, all agree in a severe limitation of the carbohydrates and fats. The modern view seems to be that the reduction to the point of abolition of the carbohydrates is the most important measure to adopt. Fats are undesirable, so that butter and olive oil should be limited, and cream should be taken in strict moderation only. If, however, the carbohydrates are levelled down to a fixed amount of bread, with a rigid exclusion of all artificial and concentrated sugars, the fear of corpulence need rarely worry us, even though a certain amount of fat be taken. It is to be remembered that obesity

is not merely an artistic matter, but also a pathological one. Insurance companies find that 'overweights' are bad lives, and every experienced surgeon will declare that he dislikes operating on fat folk, they have such poor reaction. The fat man of fifty is a danger to himself. He should set about reducing his weight, and when he has got it to the right level he should struggle to keep it there.

General opinion accords to a moderate degree of obesity the merit of first-class condition, but those who really know are agreed that the longest lived are found among the underweights. Such on the whole would seem to be the considered view of the medical profession. Doctors, nevertheless, still regard a spare figure with suspicion, especially when the weight continues to fall. A light weight which is stationary is part of the make-up of the individual, and should not be interfered with; but a light weight which continues steadily to lose demands investigation. Fat is in a very special sense the food of the nervous system, and those who are seriously worried or overworked use up their stores of fat rapidly, and sometimes disastrously. The best way of dealing dietetically with such cases is by an extra ration of diluted alkalinized milk, with its cream, given between meals. A warm bath at bedtime to encourage sleep is very helpful.

Suitability of Diet

Suitability of diet is, above all things, an individual matter. An intelligent person learns by degrees, and often by bitter experience, the kinds of food which he can best tolerate, and if he is wise he will seek to ascertain at an early age what is best for him in the matter of quantity. The standards which obtain in this matter at the present day are clearly excessive, and it is certainly on the revision of those standards in the direction of moderation that the future dietetic welfare of the nation will depend. We have become so accustomed to eat large, very unnecessarily large quantities of cooked and concentrated foods, that we regard ourselves as ill-used when asked to go back to natural foods and live simply. As in the matters of dress, exercise, and other matters of personal hygiene, so in the all-important matter of food, the nearer we can get to the simple, physiological, animal side of life, while preserving the essentials of civilized amenities, the more likely are we to escape the penalties of the arrogant assumption that we know better than Nature.

It is, for example, a great pity that the cooking-stove should dominate our attitude to the vegetable kingdom. That cookery profoundly modifies the composition of vegetable food-stuffs is everywhere admitted, and it is certain that the modification is not in all cases desirable. It is,

after all, a mere matter of fashion or custom that we should cook all green vegetables instead of using them raw, as in salads; young cabbages, young carrots, peas, tomatoes, spinach, and other vegetables are not only palatable and nutritious, but they offer a very large variety of the sort of food which, judging by the profusion with which Nature presents them, we are intended to consume in the appropriate season. It is the same with fruits. Many people deem it necessary to stew all fruits, lest, taken raw, they should cause indigestion. There is in reality no reason to believe that ripe fruit will cause indigestion. Unripe fruit is liable to disagree with delicate stomachs on account of the crude acids which it contains, but except in the rare cases of people who have idiosyncrasies in the matter of certain fruits (such as strawberries), properly matured fresh fruits are not only harmless but constitute a wholesome and refreshing form of food, whose nutrient value is, in the view of some dieteticians, very much higher than their chemical and vitamin composition would lead one to expect. In parenthesis be it said that there seems to be no sanction for the belief that stone fruits, such as plums and peaches, are less digestible than are the stoneless.

An 'Unfired' Dietary

The following is a basic working model of a so-called 'unfired' dietary. The general principle is that only those foods which are uncooked are suitable. This is, however, subject to modifications which will be indicated later. Except for those modifications the general principle of no cooked foods whatever should be adhered to. There remain therefore:

1. '*Dairy produce.*' Eggs, milk, cream, butter, cheese, cream-cheese, honey.

2. *Uncooked vegetables.* (*a*) Lettuce, endive, chicory, mustard and cress, watercress, cucumber, radish, tomato, spring onion, corn salad, dandelion, celery.

(*b*) Carrots, turnips, artichokes, parsnips, sliced very thin or grated.

With these any condiments may be taken. A dressing made with raw eggs, milk, mustard, pepper, salt, oil, and vinegar or lemon juice may be used with advantage.

3. *Uncooked fruits* of all kinds. Apples, pears, bananas, oranges, grapes, strawberries, raspberries, blackberries, peaches, nectarines, green figs. Nuts of all kinds are included. Dried fruits are not very valuable, but there is no objection to figs, prunes, and dates.

4. *Oysters, uncooked, and caviar.*

5. There is no objection to wine or spirits in the very strictest moderation. Tea and coffee in reasonable quantities are harmless.

Among cooked foods the following are permissible:

(*a*) Bread or toast, of stone-milled wholemeal bread if possible.

(*b*) Cooked green vegetables: e.g. green peas, beans, spinach.

(*c*) Eggs in any form.

(*d*) Fish, chicken, and game may be taken occasionally, but never more often than once daily.

No form of butcher's meat is allowed, and sweets and puddings of all kinds are strictly prohibited. A reasonable quantity of brown sugar in tea or coffee is unobjectionable.

From an MS. in the Trinity College Library, Cambridge

A THIRTEENTH-CENTURY DOCTOR'S DISPENSARY

V—GETTING RID OF THE WASTE

THE elimination of waste products is an important part of bodily activity; for, just as with a coal fire faulty ventilation and failure to get rid of the fumes and smoke on the one hand, and imperfect removal of the unburnable ashes on the other, will eventually interfere considerably with the processes of combustion, so with the human furnace gaseous and chemical products and unused debris must be eliminated lest impairment of functional efficiency should result. The *nature of these waste products* must first be considered.

DIGESTION AND ABSORPTION

The processes of digestion and absorption have as their aim the supply of nutriment to the cells of the body, to repair wear and tear, and to secure the intricate chemical activity which enables each cell to carry out its particular function. The results of these chemical processes vary according to the type of food-stuff concerned. The carbohydrates (sugar and starches) are eventually converted into water and carbonic acid gas (carbon dioxide) in the presence of a supply of oxygen brought by the blood. Fats likewise are completely burnt up, if the balance of other substances (principally sugar) is correct, into water and carbonic acid gas. The proteins (nitrogen-containing substances) are broken down in the digestive processes to comparatively simple chemicals, and the ultimate fate may either be that these are built up again into more complex constituents of the cells, or broken down eventually into a substance known as urea. Water and carbonic acid gas are also formed. Certain special forms of protein finish up as uric acid, but this is a very minor process compared with the production of urea. At the same time as these chemical consequences are resulting from the combustion of food-stuffs, the cells of the body may be disintegrating and contributing exactly the same variety of waste products, all of which are transported away from the cells by the tissue-fluids and blood-stream.

These are the major events leading up to the manufacture of waste, but there are others. The mineral salts of the body have also chemical reactions in the cells, partly concerned with the maintenance of the alkalinity of the blood and tissues at a constant level. If, for example, a large dose of acid is taken by the mouth the body at once attempts to neutralize any possible adverse effect of this on the tissues by calling

on reserves in the blood, and the result is certain waste products, which must be eliminated in getting the acid out of the body again. There are certain minerals which when taken in with the diet are eliminated daily in almost the same quantity as that in which they were taken in. Whether iron, for example, which is sometimes found to be behaving in this way, is being utilized and at once discarded, or whether its presence in the body is essential to permit other chemicals to work, is not altogether clear. It forms, in any case, one of the waste products to be eliminated.

The body is not wasteful in dealing with end-products, and in certain instances makes use of them before finally getting rid of them. For example, the carbonic acid gas is an important regulator of the breathing. Bile, which is largely formed out of broken-down red blood corpuscles, is an important adjunct to certain aspects of the digestion of food in the intestines before it is eventually discarded. A very large part of the solid matter finally eliminated by the alimentary canal consists of bacteria which have taken part in various processes of breaking-down food in the upper parts of the intestinal tract. The waste products eliminated by the bowel consist largely of water, and solids form only about one-fifth of the whole bulk. These are mainly cells and micro-organisms as already mentioned, as well as unabsorbed food, the residue of the digestive juices, bile, certain minerals (iron, magnesium, and calcium), products of decomposition and undigested food, such as tough 'elastic' tissue, 'keratin' (as found in nails), cellulose (the indigestible framework of starchy foods), and a certain amount of fat.

Processes of Elimination

The routes by which elimination is accomplished are through the lungs, skin, kidneys, and bowel. To a very minute extent the tears and saliva may aid in elimination when these secretions are lost to the body.

ELIMINATION THROUGH THE LUNGS.

Through the lungs the body gets rid of carbonic acid gas and water. The air taken into the lungs contains only minute quantities of carbonic acid gas (or carbon dioxide), about four parts per ten thousand. The air issuing from the mouth or nose when breath is expired contains about one hundred times as much. Even so, each breath of an adult gets rid only of just over one cubic inch of this gas, but as this process is continued day and night with every one of the twenty breaths per minute the quantity eliminated in the twenty-four hours is considerable. Water also is eliminated at each breath; that the inspired atmospheric

air, containing little or no 'water vapour' according to the conditions in which the individual is breathing, is expired fully charged with water-vapour, can be easily demonstrated by the 'steaming' produced on a cold surface, such as a mirror. Carbonic acid gas is transported from the tissues to the heart, through the venous blood, and pumped through the blood-vessels coursing through the lungs by the right side of the heart. In the lungs the fine capillaries enable the blood and the external air to be very close together, separated only by a thin layer of cells. Carbonic acid gas, held partly in solution, but mostly in loose chemical combination, passes from the blood into the air-spaces where the amount of this gas, as already explained, contained in the atmospheric air is very small. If the process could be imagined as arrested for a space of time the amount of carbonic acid gas on each side of the single layer of cells would become equal. Actually the blood is moving, and the air is moving in and out of the air-spaces of the lungs, so that this ideal state may not be altogether attained, although investigations show how very nearly the body achieves this aim.

The depth and rate of the movements of respiration are in part controlled by the amount of carbonic acid gas in the blood. In exercise, for example, the activity of the muscles leads to a greater production of this gas, and as a result of the increased amount in the blood reaching a certain part of the nervous system impulses are sent to the muscles which move the chest and to the diaphragm, with the result that breathing becomes deeper and quicker. The increased quantity of carbonic acid gas in the lungs, in the instance quoted, is exhaled from the body. Where acid is taken into the body the net result is that less chemicals are available in the blood for soaking up the carbonic acid gas produced in the tissues, so that this gas is increased in quantity in the blood, breathing is increased, and the carbon dioxide itself, when in solution being a weak acid, is eliminated. Meanwhile the safely combined acid has been passed out of the blood-stream by the kidneys as a harmless salt, and the reaction of the blood has been maintained. Poisonous acid substances produced in the body, as in certain disorders, such as diabetes, are dealt with in a similar way.

The effective elimination of carbonic acid gas, as has been explained, depends upon the difference in quantity of this gas on either side of the single layer of cells separating the blood from the air in the depths of the lungs. If the amount of carbonic acid gas in the atmosphere increases there is considerable interference with this. The principles involved in keeping the amount of carbonic acid gas in the atmosphere down to a safe level are grouped under the title of *ventilation*. It has been said above that normal atmospheric air contains only four parts per ten thousand of carbonic acid gas. Every expiration adds to this quantity, and it is commonly stated that when the proportion in a

closed space reaches one part per thousand a feeling of stuffiness is experienced. Actually, when volunteers have been placed in specially constructed chambers, and allowed to breathe concentrations of carbon dioxide gas of this concentration, there have been no unpleasant feelings so long as the temperature and the humidity of the atmosphere were kept from rising. Certain of the symptoms of stuffiness attributed to the concentration of carbon dioxide are due to these other factors. It is generally reckoned that three thousand cubic feet of air are required for each adult per hour in order to prevent the accumulation of carbonic acid gas and moisture from rising too high. (Actually the oxygen requirements of the body are served by very considerably less than this.) It is generally recommended that one thousand cubic feet of space should be allowed for each adult, so that this must be changed three times in the course of an hour to secure healthy breathing. The air must be moving, as this enables the body to get rid of water-vapour ('insensible perspiration,' see below) and heat, but it must not be moving too fast in narrow streams, so to speak, or draughts and areas of irregular cooling will occur. Ventilation is usually secured by means of windows and a fire-place. Air comes in through the windows and passes out up the chimney. Various artificial systems of ventilation have been devised to imitate or improve upon this elementary method.

ELIMINATION THROUGH THE SKIN.

The skin is a much more important organ of elimination than is generally realized. The average amount of perspiration lost through the skin of an adult man each day is over a pint, sometimes as much as a pint and a half, assuming only an ordinary quiet day's activities. Perspiration is 99% water. There is also present a small amount of urea, the end-product of protein digestion as described above, certain fatty acids, and certain salts, chiefly chlorides and phosphates of sodium, and to a less extent of potassium. In disordered conditions of the kidney where urea accumulates in the blood, the amount eliminated through the skin may be so considerably increased that a crystalline deposit is to be found all over the body where sweat glands occur, known to doctors under the descriptive name of 'urea frost.' The sweat glands are coiled tubes situated in the deeper layers of the skin, and connected to the surface by a fine tube which opens at four small orifices. The amount of sweat depends to a large extent upon the quantity of blood circulating in the skin; when the capillary blood-vessels dilate and more blood flows more sweat is produced. There is also a certain amount of control by the nervous system, both as to the amount of blood-flow, and also to a lesser extent by control of the contraction of minute muscle-fibres which surround the sweat glands.

The 'cold perspiration' which occurs after a fright is due purely to nervous causes, and represents the sudden squeezing out of sweat by these minute muscles. The degree of dilatation of the blood-vessels of the skin depends upon the control of the heat-regulating part of the brain. Where more 'heat' has been formed in the body, either by the chemical changes occurring in muscular activity, or by the 'fever' of disease, one method available of getting rid of the heat is through the skin. Actually a proportion of the total fluid proceeding through the sweat glands evaporates at once from the surface. This is known as the 'insensible' perspiration, and the water-vapour formed in this way at the surface of the skin means a definite loss of heat from the body. Over and above this is the 'sensible' perspiration which remains behind and, unless in great excess, is usually absorbed by clothing.

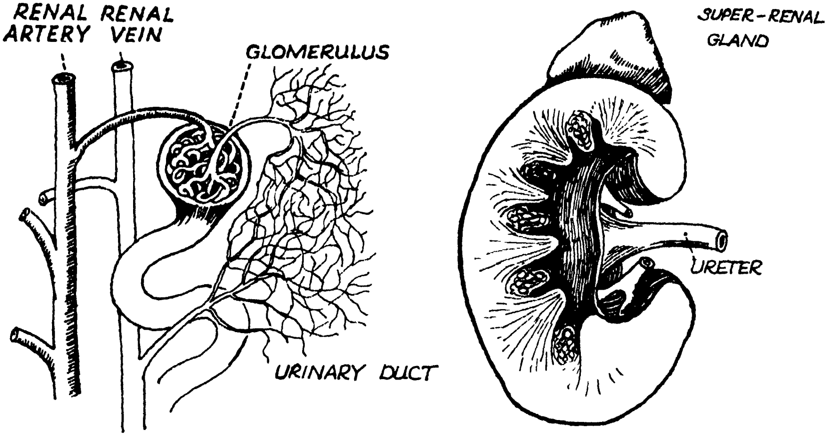
The total amount of fluid eliminated through the skin roughly varies inversely with that lost by other routes. For example, if diarrhoea is present, and fluid is being eliminated in great excess by the bowel, the amount of perspiration is greatly diminished and the skin feels very dry. If the kidneys are diseased, so that their power of fluid elimination is diminished, the amount of perspiration is greatly increased. In hot weather when the blood-vessels of the skin are dilated, and more blood is flowing through them, the amount of perspiration increases, and the amount of water passed out by the kidneys diminishes.

Since the skin is such an important source of elimination of fluid, care must be taken to ensure that its function shall not be impaired. Adequate toilet of the skin will remove accumulated grease and dirt which might considerably interfere with the loss of perspiration. If the atmosphere in which the body exists is so highly charged with water-vapour that insensible perspiration is prevented serious consequences may arise. Adequate ventilation, as mentioned above, ensures that the air is moving sufficiently to carry off water-vapour formed by this form of perspiration. In tropical climates it is the moist heat which proves most trying to Europeans, since the high degree of humidity prevents adequate loss of heat through the insensible perspiration. Higher degrees of temperatures can be endured as long as the air is dry. Clothing must be designed in all climates to allow the passage of the water-vapour of the insensible perspiration, and to take up the surplus perspiration. Loosely woven fabrics are preferable for this purpose, and closely woven cotton the least satisfactory. The 'airing' of clothes when discarded at night is important, so that the fluid accumulated during the day may evaporate.

ELIMINATION THROUGH THE KIDNEYS.

The kidneys are the most important organs of elimination. Essentially they consist of a series of filtering tubes, in portions of which the

blood is separated from the blind end of a tube by only a single layer of cells. Waste products and water can thus pass out of the blood, and the kidneys play a very important part in maintaining the level of certain substances in the blood. For example, if the amount of sugar present in the blood rises above a definite level this substance is at once passed out through the kidneys until the level in the blood again falls to normal. The kidneys also help to regulate the degree of alkalinity of the

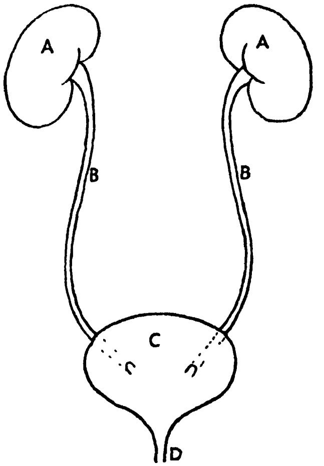


STRUCTURE OF KIDNEY

blood. As already mentioned in connection with the lungs, the taking in of acid or the formation of acid in the body at once sets in motion a chain of chemical processes designed to get rid of what otherwise might prove a dangerous substance. The kidneys aid by eliminating certain acid salts and salts of ammonia. The kidneys also elaborate certain substances in a form more suitable for elimination than that in which they exist in the blood.

The urine, formed in each kidney, passes down a muscular tube, called the ureter, to the bladder, situated behind the bones at the front of the pelvis. There it accumulates until voided down an outlet tube called the urethra. Urine is a pale straw-coloured fluid, consisting of 96 % water and the remainder solids. The quantity passed by an adult in the twenty-four hours averages about two and a half pints, but, as mentioned above, this varies with the loss in other ways, being less in the hot weather, when the urine becomes more highly concentrated. Of the solids, half consists of urea, the end-product of digestion of the protein as already explained. In smaller quantity are other end-products of protein digestion, such as urates. There are also certain salts, sulphates, phosphates, and chlorides of sodium, and potassium. The colouring matter is a special pigment, and in addition the urine contain

a certain amount of dissolved gas, mostly carbon dioxide and a small amount of nitrogen. The concentration of the solids is limited by their several degrees of solubility. Where, for example, more urea than usual has to be eliminated, the amount of urine is increased. This is also seen in diabetes, where the elimination of sugar, owing to the raised level in the blood, is accomplished only by the passage of a larger quantity of urine than normal. After being voided, urine often shows a deposit. This represents crystalline material deposited out of solution, and is frequently an indication that not enough fluid is being taken in by the body. A faint pink colour in such deposits often means the deposition of urates. The addition of hot water promptly dissolves such substances, and is a quick way of proving their harmlessness. Uric acid, the end-product of the chemical processes concerned with a certain type of protein, is normally formed to a slight extent in everybody. If the intake of certain foods (rich meats, port wine, etc.) is excessive, and in certain disturbances of the chemistry of the body, uric acid may be formed in excess—the disorder known as gout. In this case, unusually large amounts of urates (salts of uric acid) are passed in the urine. Abnormal substances getting into the blood-stream may also be eliminated by the kidneys. Thus a colouring matter, called methylene blue, if taken as a pill, passes into the urine.



A. Kidneys C. Bladder
B. Ureters D. Urethra

The exact mode of formation of urine in the kidneys is not altogether clear, although many facts are known. The main effect is one of filtration, and in damaged conditions of the kidneys, important substances, essential to the body, may get through the filters and be lost. As already stated, everything eliminated in this way has to pass out in solution, and an adequate amount of water must be filtered through the kidney to convey the waste products. Where the amount of fluid in the body has become very low (e.g. after very severe diarrhoea, or even after a severe haemorrhage) the kidneys may cease to work—with disastrous consequences. To prevent minor degrees of derangement of the working of the kidneys adequate amounts of fluid must be taken daily.

The formation of urine in the kidneys goes on continuously, day and night, but in healthy people there is a considerable reduction during sleep, so that the quantity passed first thing in the morning is considerably less than that which would be passed after a similar period

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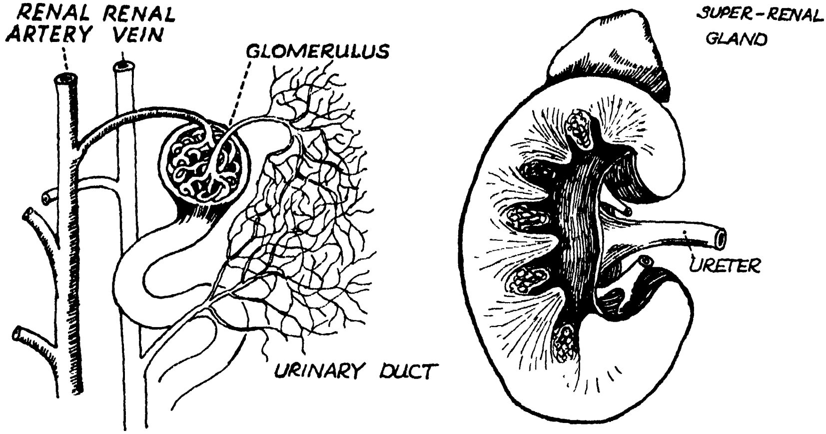

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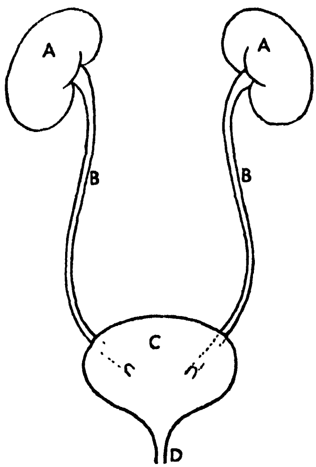

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The formation of urine in the kidneys goes on continuously, day and night, but in healthy people there is a considerable reduction during sleep, so that the quantity passed first thing in the morning is considerably less than that which would be passed after a similar period

of waking activity. Such morning urine is, however, more highly concentrated than that passed during the day. With increasing age, and in certain disorders, this daily variation in the activity of the kidney tends to disappear.

Although urine is more or less continuously passing from the kidneys down the ureters to the bladder, the actual voiding of urine, by the emptying of the bladder, as we all know, only occurs at intervals. The bladder is a hollow muscular organ with two inlets, the ureters, one from each kidney, arranged in an oblique manner to prevent back pressure. There is also one outlet controlled by a circular collection of muscle-fibres known as a sphincter. Once this sphincter is relaxed urine passes freely down the urethra, and is voided. The control of the bladder and sphincter is partly by the voluntary nervous system and partly by the autonomic or involuntary nervous system. In the adult, the mechanism is roughly as follows: As the amount of urine increases, the distended bladder begins to contract rhythmically, and when this reaches a certain degree the desire to pass water is experienced. The individual then raises the pressure in the bladder still further by contracting the diaphragm and so increasing the general pressure within the abdominal cavity. The effect of this is to squeeze the first few drops of urine through the sphincter at the outlet of the bladder into the first part of the urethra (the outlet tube). The entrance of urine into this portion of the urethra initiates a reflex action. The sphincter relaxes, and the bladder contracts steadily until emptied. No further voluntary effort is required, although the process of emptying the bladder may, to a certain extent, be hurried by continuing the increased abdominal pressure. The contraction of the sphincter controlling the outlet of the bladder may be brought about by a voluntary effort so that the outflow of urine is interrupted, but relaxation of this sphincter is not under voluntary control.

Certain points connected with the hygiene of urination arise from this brief account of the mechanism involved. The initiation of the process may be grossly interfered with where disease of the chest or of the abdominal organs prevents the initial raising of the intra-abdominal pressure. In sick patients where there is a possibility of this, steps must be taken to secure that urine does not accumulate in a distended bladder. In other diseased conditions—for example, of the nervous system—the reflex action of the bladder may be prevented from taking place, or the desire for micturition may not be experienced. Regular passing of the urine at fixed intervals is then necessary to avoid dangerous retention. Where there is retention of urine, from any cause, steps must be taken at once to secure expert advice, and pending the arrival of assistance it is recommended that the patient be given warm drinks and be placed in a warm bath.

The description given above refers to the process in an adult. In the baby there is at first no voluntary control, and as soon as the pressure within the bladder reaches a definite level it contracts, forces some urine out through the sphincter (which is not very tightly contracted at this age), and so the process of urination takes place, usually at frequent intervals during day and night. Much may be done, however, to train the baby to control the process. The passage of urine frequently occurs when the napkins have just been removed, and by sitting the baby upon a chamber before and after every feed it is soon possible to produce a 'conditioned' reflex act so that the passage of urine is associated with the chamber. A skilful nurse will often train a baby in this way from the early months of life.

In later childhood, even where this early training has been successful, unsatisfactory control of the bladder arises in certain instances, both during the day and even more commonly during the night. Provided that disease of the kidneys and bladder can be excluded, the daytime loss of control is largely a question of habit, comparable to nail-biting or nose-picking. In other words, there is sometimes something in the child's psychological make-up or environment which interferes with the normal control of parts of the nervous system. Removal of such causes combined with a fresh training of the bladder by insisting upon regular emptying at fixed times by the clock, the period during which the urine is held being gradually prolonged, will usually effect a cure. The loss of nocturnal control, or bed-wetting, is a more complicated problem. Here again psychological causes must undoubtedly be recognized. It is well known that a persistent bed-wetter will often cease to give any trouble if taken into hospital or allowed to sleep with an adult. Other factors, however, come into the problem, such as over-activity of certain parts of the involuntary nervous system. This has recently been shown to be due in some instances to a special hypersensitivity to certain foods, notably the fats obtained from the pig (bacon, lard, etc.). Restriction of fluids towards the end of the day, regular waking at 10 p.m. to pass urine, etc., are all measures which have to be considered in effecting a cure.

ELIMINATION THROUGH THE BOWEL.

The bowel is the last important route of elimination of waste products which must now be considered. It has already been stated that the waste products got rid of in this way consist of unabsorbed food, undigested food, bacteria, the residue of the digestive juices, etc. Normally these substances are present in the last portion of the large bowel as semi-solid 'faeces,' of which, as has already been pointed out, four-fifths are water. The normal colour is brown, due to the presence of altered bile pigment, and the bulk varies greatly according to the

efficiency of digestion and absorption, etc. A normal adult eliminates about six to eight ounces of faeces in twenty-four hours. The large bowel, in which the final formation of faeces takes place, is the chief site of absorption of water, for higher up in the digestive tract the contents are more liquid. Wave-like movements of contraction and relaxation take place, possibly in both directions, certainly in an onward direction, the object of which is a continuous kneading and stirring process to ensure that as much water as possible shall be absorbed. Higher up, in the small bowel, the movement of the contents is a more or less steady onward passage. In the large bowel there is more regulated delay. If a special biscuit containing bismuth (which is opaque to X-rays) is eaten, and its passage followed by means of X-ray examination, it will be found to have reached the last part of the large bowel just over twenty-four hours later. Ordinary food probably takes longer; and faeces passed to-day are derived in great measure from the food of the day before yesterday.

The residue of the contents of the digestive tract is eventually passed on into a large s-shaped loop known as the pelvic colon. Beyond this is the last part of the digestive tube, known as the rectum, the exit from which is guarded by a muscular sphincter. The rectum is normally empty, but as the pelvic colon becomes more and more loaded some faeces pass on and enter the rectum. This causes two things to happen: a definite sensation passes back to the central nervous system, interpreted past the age of infancy as a 'call to stool,' and at the same time the muscle in the walls of the rectum slightly contracts into a sort of braced-up condition. The next part of the process is under voluntary control. As a result of the sensation experienced the individual decides to pass a motion. The pressure within the abdominal cavity is raised by contraction of the diaphragm (as with the beginning of the act of urination), and faeces are forced from the pelvic colon into the rectum in quantity. This hollow muscular tube then begins automatically to contract rhythmically with an onward motion, the sphincter is relaxed, and the faeces are expelled.

Such is the process in the normal, healthy individual. Where the nervous system is seriously disordered, all voluntary control may be lost, and the moment faeces enter the rectum, even in small quantity, they are automatically expelled. This is sometimes called 'false diarrhoea.'

True *diarrhoea* means that the whole process of the movement of the products of digestion down the food canal has been speeded up, and the green colour of the frequent stools of this condition is the normal colour of the intestinal contents higher up the digestive tract. Because of the rapid onward passage of all the contents, there is very little absorption of water, and it has already been mentioned that a serious

loss of fluid may rapidly occur in this way. Diarrhoea means usually the irritation of the wall of the bowel by unsuitable or maldigested food, or by inflammation set up by certain microbes (as in typhoid fever). It is a serious symptom in the young baby, and should not be regarded lightly at any age. Diarrhoea lasting for longer than a day should always lead to the seeking of skilled advice.

The opposite state of affairs is much commoner and usually means that in the absence of any real disease of the nervous system or of the bowel the normal process has been interfered with, and difficulty in the elimination of faeces occurs.

This is known as *constipation*, and this widespread disability of civilization must now be discussed in the light of the description of the normal mechanism given above.

In the first place it is obvious that the contents of the colon (large bowel) may be abnormal. If the diet contains no 'roughage,' that is to say, food that will leave some undigestible residue, the bulk and consistency of the faecal material may not be suitable for the normal onward passage. 'Roughage' is to be found in brown bread, fruit, green vegetables, and salad material in particular. Similarly the daily intake may not include sufficient water, so that by the time the colon has absorbed as much as it can the resulting faeces may be hard and dry. Normally the wall of the colon contributes a certain amount of mucus to lubricate the final passage of faeces, and one type of constipation shows itself by passage of excess of such mucus, evidence of the irritation of the hard faeces on the wall of the bowel. A person who is ill in bed on a light diet may readily become constipated on account of a sudden diminution of the bulk of unabsorbed food, etc., left in the large bowel. These causes of constipation should all be regarded as easily remediable by adjusting the diet or fluid intake, along the lines suggested. No medicines should ever be taken in such instances unless the diet and water intake have been under review. In cases of illness the conditions are different, and *under medical advice* various laxative or purgative drugs may be valuable.

Another type of constipation occurs because the normal 'call to stool' is neglected. With many people the sensation caused by the overflow of faeces from the pelvic colon to the rectum occurs daily at a fixed hour (e.g. after breakfast), and the natural series of events outlined above then takes place. With others, encouraged by the rushing tactics of civilization, the sensation is gradually disregarded. At first this means that the rectum becomes more and more full of faeces until the state of tension of the muscle in its walls can no longer be ignored. Still later in the process of interference with Nature's mechanism, even this part of the reflex act is checked, so that eventually the inflicted individual has destroyed the muscle-tone of the rectum, and its

capability of easy, almost effortless emptying, once the initial filling-up process has begun. Instead of the rectum actively voiding the faeces, all the energy required has to be supplied by increasing the intra-abdominal pressure to force the faeces out of the rectum, a relatively inefficient way of effecting this.

A somewhat similar state of affairs may be present in the young baby. At first the passage of faeces into the rectum is followed by immediate elimination, but after a few weeks some increase of voluntary control can be established, particularly if the mother or nurse responsible attempts to train the child. It is not always easy to secure that the child will carry out the necessary movements to pass faeces from pelvic colon to rectum in sufficient quantity to set up the final stage of elimination. This 'laziness' on the part of the baby may very easily develop into the type of constipation mentioned above.

It is obvious that the cure of constipation of this variety and the prevention of its occurrence in the young are both matters of training and habit. It is not difficult to train the baby to associate the sensation of the chamber applied to the buttocks with the necessity for holding the breath. If the rectum seems reluctant to effect the final elimination, it may be aided by the gentle insertion of a vaselined finger into the entrance into the back passage. This local stimulation is sometimes necessary for a few days until the normal habit is established. The passage of hard, dry motions in the young baby generally means that not sufficient fluid is being taken daily, and drinks of water may have to be increased.

Though the dangers and evils of constipation have sometimes been exaggerated, it is not a healthy state of affairs, and irritation of the bowel may lead in time to serious troubles. The relationship of appendicitis to constipation is probably a close one; while in young children constipation has been thought to be responsible for other acute abdominal catastrophes.

It is therefore important that constipation should be remedied, but as far as possible only along the lines of re-education of the bowel and rectum to perform the natural series of movements. For babies the methods available have already been outlined. For adults they are much the same. Aided in some instances by decreasing doses of suitable medicine, and in all cases by a sensible diet, the sufferer from constipation should make an effort daily at a fixed hour, and at no other time unless a definite call to stool occurs. Massage of the abdominal muscles sometimes helps; while a good time to start the 'cure' is after a holiday, when the body is thoroughly fit. In this way people who have been constipated all their lives can be re-educated to a daily effortless stool.

A word may be said about the general attitude to constipation.

Every individual probably has a routine for the bowel which, in healthy subjects, goes on without any serious thought about it. The happiest answer to the question: 'Are the bowels regular?' would be 'I don't know, I never think about it.' The passage of a motion once a week or even once a fortnight has been recorded in individuals seemingly enjoying perfect health. This is, of course, exceptional, but it shows how elastic the rules of Nature may be. Attempts at securing a daily motion in such individuals by means of purgatives might well spell disaster. Too much straining at stool is likewise wrong. The normal action of the rectum, as has been described above, should be automatic once faeces have been squeezed from the pelvic colon into the rectum. Excessive straining in order to empty the rectum itself implies a faulty mechanism. In not a few instances persons have been found dead with a burst blood-vessel in the brain as a direct result of straining at stool. A 'rupture' may also sometimes be brought about in this way, and for this the position adopted at stool is probably to blame. If lower seats were used in all our lavatories there would be less risk of rupture, as then the legs are well bent up, the thighs almost touching the abdomen, and the weak spots in the folds of the groins well protected.

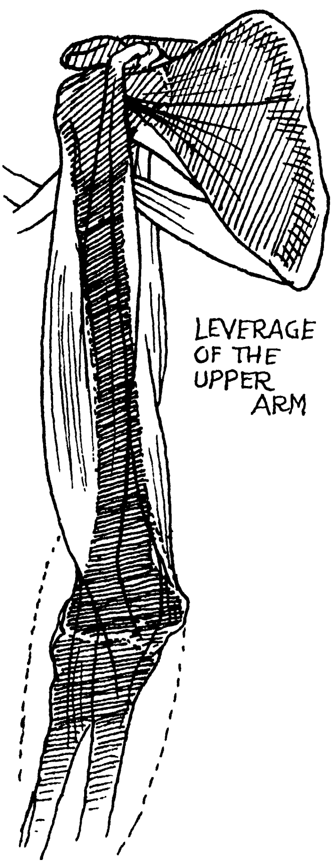
Constipation of long standing probably implies faulty habits, and may be remedied along the lines described. Sudden constipation arising in a previously normal person is quite another matter, and may be the signal of some serious malady. The injudicious use of any purgative on such occasions is dangerous.

MINOR FORMS OF ELIMINATION.

The foregoing contains an account of the usual processes of elimination of waste products. Under unusual circumstances two other very minor routes may play a small part in the eliminatory processes. The *saliva* contains traces of sulphur and calcium, and may cause a loss of these substances to the body. The *tears* contain about two parts per hundred of solids, of which over two-thirds is common salt. It is unlikely that much elimination will take place in this way!

VI—THE MECHANICS OF THE HUMAN BODY: ITS LEVERAGES, MOVEMENTS, AND SUPPORT

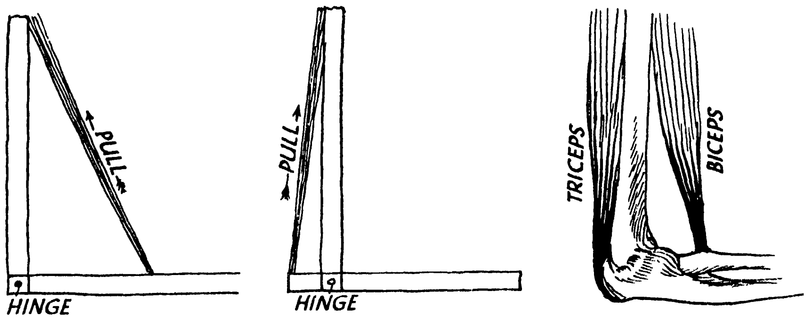
WHEN man adopted the upright position, and began to go about on two feet only, he set himself a problem in mechanics that might puzzle the most expert engineer. Roughly, what he set out to do was this. To upend and keep erect without outside support a column some five or six feet high, so flexible that it would bend nearly double, and could rotate spirally on its axis through half a circle. Projecting from this column were two jointed extensions, which he had to place and maintain at any given angle with the column, lifting and supporting them by means of adjustments within themselves, without other help. The whole of this flexible mechanism was to be balanceable in every possible position on two flat surfaces, each less than twelve inches by four.



The mechanical problem of the quadruped is a very much simpler one. To begin with, stability when supported at more than two points is relatively easy. Balance hardly enters into it. The four limbs carry a bony framework from which all the structure hangs, only the raising of the head and neck presenting any serious difficulty. Where, however, as in the biped, the arm, for example, attached at a single point, has to be lifted, complicated questions arise. The rigid, jointed bones, of which our skeleton is composed, are held together and moved by elastic ropes and bands called muscles and tendons; but the only positive action of these muscles is contraction, with consequent shortening. They pull, but cannot push. Their 'support' is the support of a string, not of a stick. When we say lightly that we 'lift' an arm, we

clearly do not lift it as we lift a parcel from the ground. Although the action is unconscious, we are employing an elaborate system of levers; a system which is operative throughout the whole body, without which we should collapse as does a person in a faint. In fainting, the muscles relax and release the various adjustments of the joints; these give way, and the whole structure tumbles in a heap.

Before it is possible to understand the mechanics of the human body we must grasp the essential principle of the lever, on which principle the whole is based. The levers within the body are of two kinds.

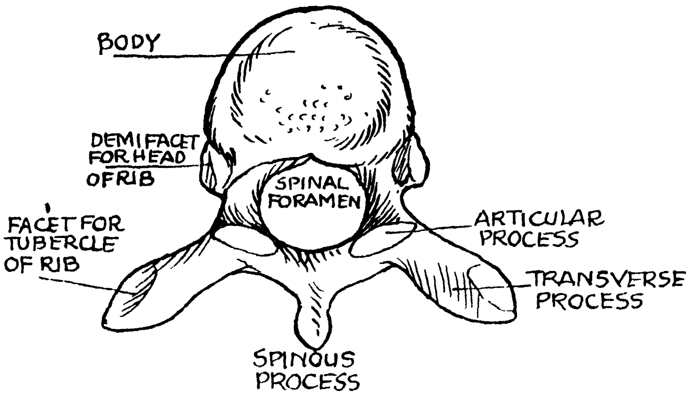


DIAGRAMS OF THE SIMPLE LEVERS OF THE ARM

In the first and simplest we have two arms jointed together, with a cord attached to one at some point within the angle formed by the two arms. When the cord is pulled the free end of the arm rises towards the pull. The greater the space between the hinge where the two arms join and the point of attachment of the cord, the less will be the pull needed to raise the arm. In the second kind the two arms are hinged as before, but not at their extreme ends, and the cord is attached to the end of one, outside the angle formed by them. When tension is applied to this cord the opposite end of the arm will move in a direction away from the pull. The nearer the attachment of the cord to the hinge of the arms, the larger will be the arc described by the free end, but also the stronger will be the pull required. The whole of the work of supporting and moving the human body is done by levers of these two kinds.

The human skeleton is made up of more than two hundred bones, and in the normal person nearly all of these can be moved more or less freely in relation to each other. This movement is the work of the muscles. At the point of apposition of two bones they form what is called a joint, and these, in the human body, differ in their construction. The elbow joint is typical of the simpler of these, and is like the hinge of a door or box, in that it only permits of a straightforward to-and-fro action. The hip and shoulder joints are of the ball-and-socket kind,

permitting much freer motion; the wrist allows of back-and-forth, as well as sideways, movements, but of no rotation; while the simplest of all allow only very limited play, as do those which connect the ends of the ribs with the spine. The surfaces of bone which, in the construction of one of these joints, come together, are lined with an elastic gristle or cartilage, on which these surfaces glide; and round the whole piece of mechanism is a kind of fibrous coat, firmly adherent to the bones, and holding the whole in position. The internal cavity of a joint is lined with a membrane which secretes a fluid lubricant, called the synovial fluid. Joints are further strengthened by the tendons of muscles



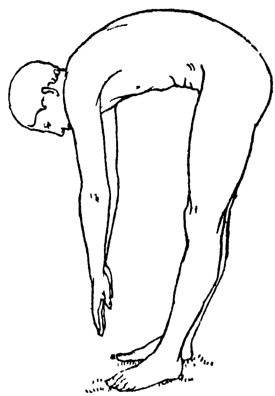
A DORSAL VERTEBRA
From above

passing over them, which act as binders, and by the tough fibrous bands called ligaments, which are attached at their ends to the bones which they support.

The spine, being the most difficult piece of engineering in the whole body, and forming, as it does, the central column round which our whole structure is built, may serve as an example of the mechanisms by which we stand and move. It must be remembered throughout that only bones can support; muscles can but pull.

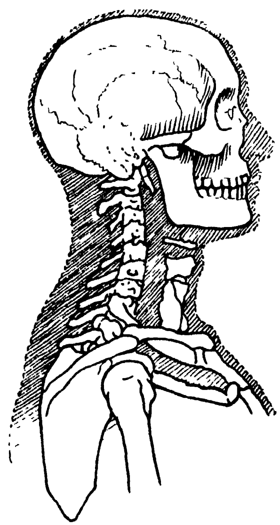
The spine consists of thirty-three bones. Seven of these make up the neck, and are the most freely movable. Below the neck or cervical vertebrae come twelve belonging to the chest, the dorsal vertebrae; five more lie in the loins, the lumbar vertebrae; and five are joined into one bony mass, the sacrum, at the back of the pelvic ring. The four last, the coccyx, are the rudimentary tail; and in the skeleton show as an incurved hook. All these bones are piled one upon the other, and held together by strong muscles and ligaments. They bear the weight of the body, and the lowest are the largest and thickest, as they carry most. The vertebrae are all alike in essential shape, but they vary very much

in their relative proportion of parts according to their uses, and to the attachments of their various muscles. Each has a solid body, the innermost part of the bone, the outer being a kind of ring formed by a transverse knob or process on either side, and a spinous one between them on the outer surface. Within this bony ring the spinal cord is carried right through the body. Smaller processes on the upper and lower surfaces articulate with the neighbouring vertebrae, and between are disks of gristle or cartilage, growing on the surfaces of the bones and permitting their free and gliding movement on one another. The whole series of bones is held together by elastic bands of strong ligament; the bodies by two, extending right from top to bottom of the column, one in front and one behind; and by a series of shorter ones at the sides joining pairs of vertebrae together. Other bands lie in the hollows between the knobs, and link up the spinous processes. In the cervical region this last set join to form the big ligament at the back of the neck.



NORMAL FLEXION OF SPINE

If the disks between the vertebrae were absent, the bones would lock upon each other and prevent the movement of the spine. As it is, the whole column of the backbone, except the sacrum and coccyx, is movable; but movement is most free round the waist and loins. A few moments spent in action before a mirror will show this clearly. The thoracic region and the pelvis keep their own shape, only altering their relation to each other; the waist and loins show most of the effect of action.

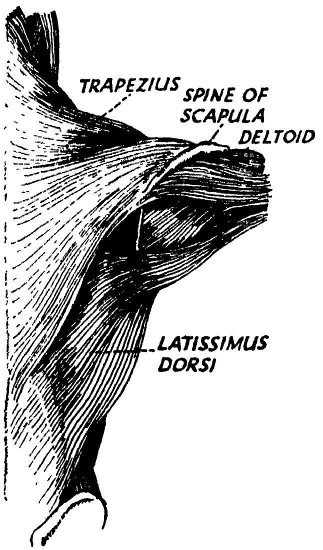


BONES OF THE HEAD AND NECK

The spine is never quite straight when seen from the side, though from the back it should appear absolutely symmetrical. It has four back-and-forward curves, called the normal curves, due almost entirely to differences in the shape and thickness of the intervertebral disks. The movement of the spine is controlled and limited by the locking and interlocking of the vertebrae and their processes. The ribs, which are jointed to the twelve thoracic vertebrae, prevent much movement of that region. A study of the shape of the vertebrae at various parts

of the spine will show why bending forward is easy, whilst backward and sideways movements are mechanically more limited. Rotation or spiral movement is freest in the higher parts, such as the neck, the interlocking transverse processes interfering with it round the loins.

The muscles which hold up and move the spine do not all, of course, do this alone. They act as well on the bones and muscles to which they are attached at their other ends. But, roughly speaking, there are five layers of muscle which act in this way. On the outside the great sheet of muscle which covers the surface of the back, the trapezius and the latissimus dorsi, does its share in holding all together. Then come two which pull from the side processes of the upper vertebrae to the inner and upper edge of the shoulder-blade, the levators. Then two, one on each side, the rhomboids major and minor, which pull from the lower cervical and the five upper dorsal vertebrae to the lower inner edge of the shoulder-blade. Further in still lies the splenius, which attaches the lower part of the great ligament of the neck, the lowest cervical and the upper five dorsal vertebrae to the base of the skull and the knobs of the upper vertebrae. This muscle, when contracted, has a twisting action on the neck and head, those on either side counterbalancing each other and normally acting to keep the head firm and erect. In 'round-shouldered' persons this is slack and weak. Like all the muscles which hold up the spine the splenius has, so to speak, no beginning and no end, as it fans out into separate insertions throughout its length, so as to act on all the vertebrae which come within its sphere of influence.

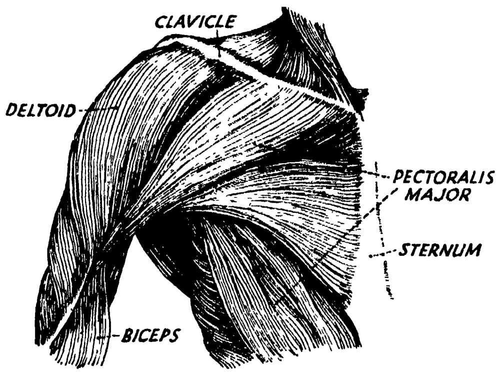


MUSCLES OF THE CHEST AND SHOULDER
Back view

The next muscle in depth is the great erector spinae, which lies right up the back from the sacrum, the hip bones, and the lower vertebrae, to the skull, the upper vertebrae, and the angles of the ribs. Beginning as one mass, it divides as it rises, and pulls on practically all the processes of the vertebrae, holding them together. As every strand of this muscle is capable of separate action, it will be realized how powerful a bending effect on the spine is produced by the drawing together by its means of any two vertebrae or groups of vertebrae. The oblique extensors also extend throughout the length of the spine. They run like a kind of plait from the transverse processes of one vertebra to the middle or

spinous process of another, usually four or five higher up; continuing thus for the whole length of the backbone. These pull downwards and sideways, and can act together or separately. The last and most deeply seated muscle is a flat sheet called the quadrator lumborum, which comes from the upper border of the pelvic mass and the side processes of the four lowest lumbar vertebrae, and ends on the transverse processes of the upper two lumbar vertebrae and the lower edge of the lowest rib. This helps to bind together the whole of this part of the structure.

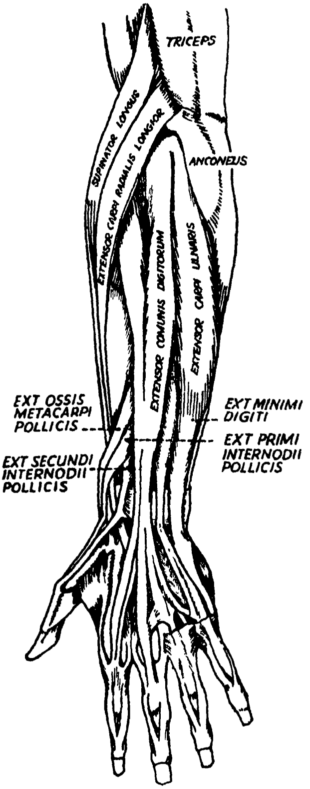
Consideration of the mechanics of the vertebral column will explain a great deal about the choice of exercises designed to strengthen and supple the back and trunk. The spine is of the utmost importance in the maintenance of our health; directly in keeping our movements co-ordinated and strongly and correctly balanced; and indirectly in keeping our organs and our muscular structures in their true relation to one another. It has also a high duty to perform as the guardian of the spinal cord, without which, as has been said, all vital activities become impossible. This complicated piece of machinery, then, when subjected to analysis, is found to consist merely of an elaboration of the simplest levers, set at every kind of angle, and acting singly and in collaboration with each other and with other groups. This collaboration and interaction is the basis of the rhythm which is found in all bodily movement, in greater or less degree.



MUSCLES OF THE CHEST AND SHOULDER
Front view

When we perform a simple action, such as raising a spoon to our mouth, we carry out a blend of several movements. We raise the hand, bend the arm, and so guide the combination of these two actions as to bring the spoon to the desired spot, and then stop it. Clearly if we merely contract the muscles which bend the arm and those which raise the hand, the resulting action will be a jerk; the spoon will fly up, and we shall land its contents in some quite unwished-for place. In order to perform any desired movement, two sets of muscles at least must be brought into play: those which move the limb, and those which check its movement. When we flex the elbow we use both the flexors and the extensors; on the balance of the two pulls depends the rapidity and the force of the action. This balance is found throughout the body,

and in every movement we make, though the delicacy of its adjustment varies enormously. The baby has to develop this adjustment little by little, beginning with movements which to the adult have become unconscious, such as walking and putting food in its mouth. The baby's spoon, at its first attempts, is as often in its ear as in its mouth. It has not yet acquired the knack of using one set of muscles to control the other. So with walking, picking up and putting down objects, and other movements which, later, seem as easy as breathing. The 'awkward,' 'clumsy' person is the one who has never really learnt this muscular knack. He does not truly balance pull against check, so that he uses too much or too little force; either stops his action too soon or carries it on too long. All the manual crafts call for special training of this adjusting power. The watchmaker must be able to count on absolute control of the tiniest movements of his fingers, to apply exactly the amount of power needed, not a fraction more or less. His task is made easier by the delicacy of his work; where force as well as fine adjustment is called for, the control is more difficult. The blacksmith usually has hands and arms finely and very evenly developed; for the work which he does is often not only careful and intricate, but calls for strength as well. His muscles, while strong, must be in perfect balance.



MUSCLES OF THE FOREARM
Back view

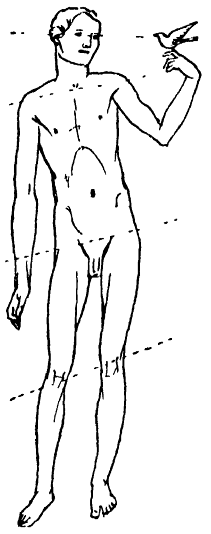
All these complications of action, at first conscious, soon become subconscious with use. The mere hint given by the brain will set going the whole series of pull against pull, movement against check, so that the action seems to us to carry out itself. Sometimes, indeed, it returns to consciousness when some hitch occurs—as when, in typing, a word is spelt incorrectly, the brain will become aware that something is wrong, and will stop the fingers until the fault is found. A whole series of actions of this kind will become linked together by habit, so that one will automatically set all the others going; and circumstances may so govern such a series that it may occur even though the essential original factor be absent. Thus a person accustomed to riding a horse may, when first driving a car, grip the steering-wheel and stiffen his

legs if he sees a dust-bin in the act of falling off a cart beside him, though his intelligence knows quite well that the car is not going to shy. The old chain of reactions is set going by the familiar emergency. So, too, more simply, a person who has been accustomed to use a typewriter with one arrangement of keys, cannot use a machine with its keyboard differently disposed. The gradual adoption of a standard keyboard for all makes of typewriter is due to the recognition of this fact.

Grace in the carriage of the body results from the rhythmic and co-ordinated action of the muscles, without jerky or disconnected movements. So carefully adjusted is the balance of the body and the pull of muscle against muscle, that hardly any movement—the raising of a hand, or the turning of the head—can be performed without some small adaptation of every other part. If we sit in a chair and, without paying special attention to our action, turn the head to look at a person standing behind us, we shall find that every bit of us is moving slightly, following the spiral motion of the neck and head. This 'follow-through' movement is the basis of all graceful and natural action. If we stand upright, with the feet slightly apart, and lightly shift our weight from one foot to the other, we shall feel the swing and settling of all our muscles. The shoulders will alter their slope, the hips will tilt a little, the head will move on the neck. If, in front of a mirror, we keep the body rigid while raising the hand and arm, or turning the head, it will be seen at once how stiff and awkward these movements look.

Graceful muscular balance and flow is sometimes found in natural conjunction with a well-proportioned frame; but it can be cultivated and increased by exercise and training. Though in itself a natural quality, it may also be greatly helped by the formal practice of non-natural rhythms. By this is meant the movement of the body in opposition to its instinctive impulse. When we walk briskly, we swing our arms in a certain relation to the time of our steps. When we turn our shoulders at an angle, we turn our hips at a similar one. When we stretch an arm forward, we put out the foot at the same side. The deliberate practising of the opposite of these and similar impulses greatly aids in acquiring grace and body-control. The human body, by reason of its enormous number of adaptations, differs more in appearance from those of its mammalian relatives than do any of these among themselves. Man has gained an advantage over the quadruped types in his versatility, but he has lost on individual qualities which distinguish many of these poor relations. He is Jack of all trades, but master of few. He is not so swift as the horse, so powerful in grasp as the bear, so nimble as the goat, or so strong as the bull. But the adaptability of his build gives him the dominance over these other specialists. The freer use which he makes of his limbs gives him a more even balance of mass; his body is smaller in proportion to his legs and arms, and he

can employ a very much greater variety of posture. His muscle-leverages are more complicated, and, though he has lost many of the advantages of the quadruped, he has succeeded in countering a good many of the disadvantages incurred by the erect position.

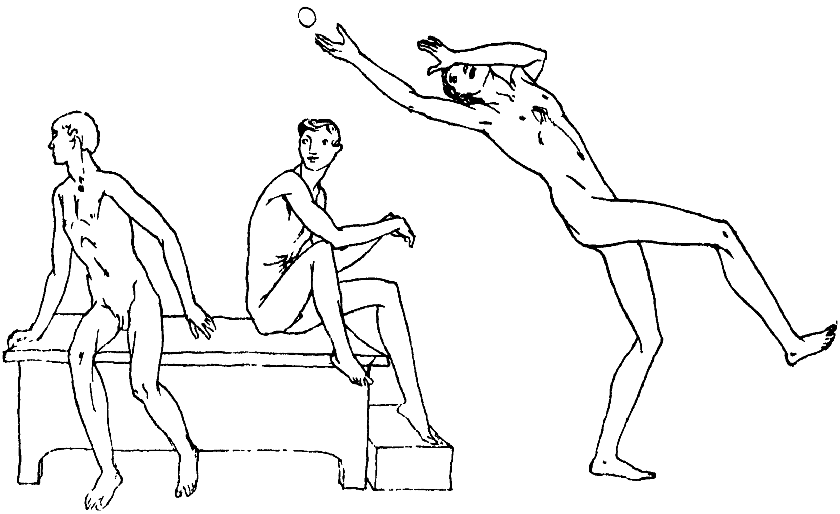


RHYTHMIC CO-ORDINATION

We can trace throughout the structure of man's body his kinship with what we call the lower vertebrates; still more strikingly his similarity to the rest of the family of the mammals to which he belongs. His ancestors were presumably quadrupeds walking on their hind limbs, and all his adaptations to the upright position are of a makeshift kind. Many of our organs are primarily constructed for use in the horizontal position, and although we make do with them in a wonderfully complete fashion, they call for more effort and strain on the part of our nervous and muscular mechanism than they did in their earlier arrangement. In the quadruped, the cage of the ribs hangs supported freely by the spine, swinging forward and back without muscular effort as the lungs expand and contract. In man, the whole bony cage has to be lifted at each inspiration, and it shows, accordingly, a change of shape, a flattening and broadening, which makes this work easier to perform. Several of the greater and more powerful muscles, particularly those of the buttocks, are practically out of action in normal upright walking; the gluteus maximus only coming fully into play when the leg is at an angle with the body, as in the quadruped. This, it has been suggested, accounts for the success of the 'crouching start' in running, for the forward posture of racing bicyclists, and for the fact that elderly and feeble people habitually bend forward when climbing stairs, all positions which bring this muscle into powerful action.

Our muscles seem to have been re-adapted in order to keep the viscera from sagging down into the pelvic basin, which, given the musculature of the quadruped, they would tend to do. All our structures, instead of hanging easily and naturally from the backbone, stand out from it at an angle, greatly increasing the difficulty of the problems resulting from the erect position, the maintenance of which is itself difficult enough.

This question of the sagging viscera is connected by Sir Arthur Keith with the disappearance of the tail in man. Man, he points out, is descended from tailed ancestors, and preserves all the bony structure of this tail in the small bones of the coccyx, which curves inwards

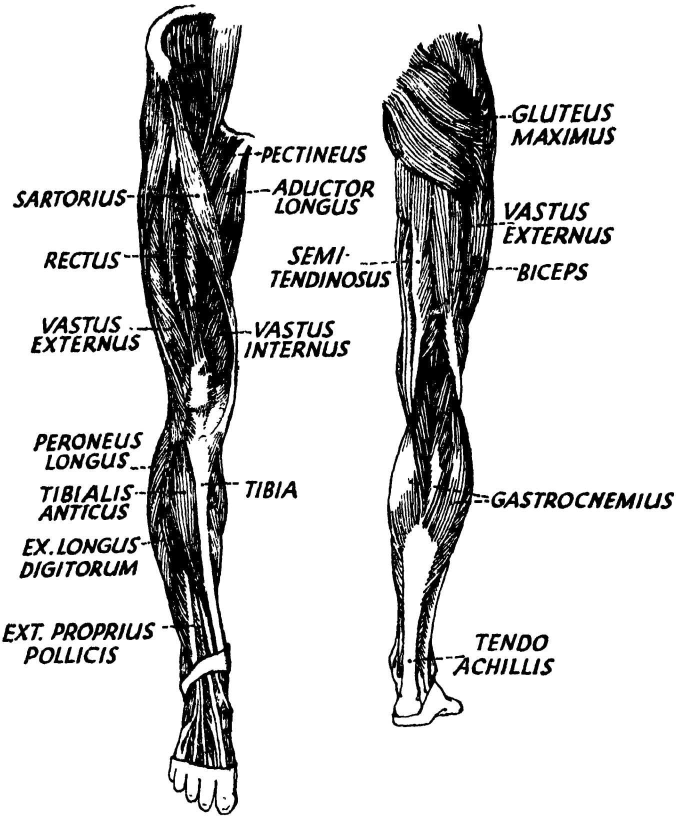


PULL-THROUGH SPIRAL ACTION

sharply at the lower end of the spine. In the anthropoid apes the tail has disappeared as with man. 'When it is remembered,' says Sir Arthur, 'that it is only these higher primates which have attained the erect or upright posture, it will be at once suspected that the disappearance of the tail is a result of change of posture. There can be no doubt that this is the case. When a monkey is held upright its viscera gravitate downwards, and need support from below. The muscles which close the hinder end of the body are the muscles which depress the tail; by depressing the tail the monkey can support or shut in the contents of the abdomen. In man, the greater anthropoids, and in the gibbon, we find the muscles which depress the tail spread out as a muscular hammock across the pelvis to support the viscera. With the evolution of the upright posture the tail became useless as a balancing organ; the centre of gravity of the body became then quite altered. The muscles which depressed the tail were needed for the support of the abdominal organs, and hence the tail became useless in the new economy which was established, and became buried or coccygeal in form.'

The skeleton of the trunk, as well as supporting all the tissues, serves as a protective box for all the important organs. The crab and the lobster, with many other creatures, have carried this plan to its extreme, having all their bony structure on their surface. The human skeleton is admirably fitted for its purpose of strength and lightness, the elastic ribs, for example, being far less cumbrous than any equally strong

arrangement of solid plates. It was, however, even more completely protective when man or his ancestor was quadrupedal. In a state of nature, danger is far more probable from objects and blows falling from above than from anything below. The soft parts of the body—then



Front view Back view

MUSCLES OF THE LEG

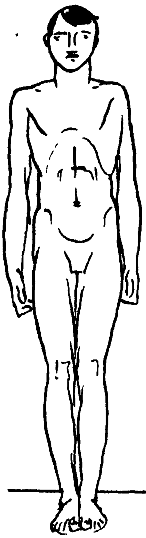
the underparts—were protected by ribs, backbone, sacrum, and shoulder-blades, the only unshielded bit being the short interval between the lowest rib and the sacrum. As we are now modified, the back of the neck would, in walking on all fours, be a vulnerable part; but in the true quadruped the different leverage necessary for the forward carriage of the head brings the spine lower at that point, and covers it with a layer of very strong muscle. At present, direct downward blows are taken on the thick bony cap of the skull; below this, on the strong

shoulder-girdle; below this, again, the iliac crest (where the upper edge of the pelvis thickens) protects, with the flat sacrum, the sides and back of the soft abdomen. Also, as bipeds, we can now use the arm and hands for the warding off of blows and other injuries from the relatively exposed organs in the lower part of the front of the body. The arms and legs, which contain no structures of vital importance to the organism,

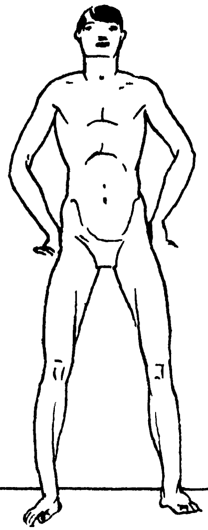
EQUAL BALANCE ON A SINGLE POINT

have their bones in their middles, covered and protected by layers of elastic muscle. The spinal cord, the great basic extension of the brain, through which messages are carried to all parts of the body and without which co-ordinated movement is impossible, is completely enclosed in the jointed box of the vertebrae, themselves armoured with bony knobs and covered with thick muscle.

The mass of the trunk, composed of its arrangements of bones in interplay, and its balanced muscles, is used by the limbs as a basis for leverage and muscle-contraction. It will be noticed that when a violent or unusually powerful movement of the limbs is undertaken, the trunk is stiffened and the breath held, with the lungs fully expanded, locking



EQUAL BALANCE

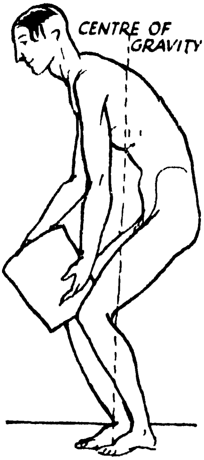


EQUAL BALANCE
ON TWO POINTS

UNSYMMETRICAL
BALANCE

the trunk into one rigid mass. This provides a firm hold for the pull of the contracting muscles of the limbs, and gives great additional force. In carrying out long-continued hard physical work, it is usually possible to shift the strain from one group of muscles to another, at intervals, so as to rest those most fatigued. Pulling with a rope, for example, may be carried out in series by (mainly) the hands, wrists, and forearms, the shoulders and chest, the loin-muscles, and even the muscles of the thighs and legs. Of course, in none of these cases does the one group act alone, but the strain can be deliberately thrown first on one and then on another. So, if we stand for a long period, we shift the weight from foot to foot; bringing different groups into play, contracting the fresher ones, and relaxing the more tired.

The body is normally supported on the under-surface of the feet, consisting of the pads of the heels and the pads of the toes, connected by an elastic arch called the instep. When the weight is put equally on the two feet, with the body upright, a line dropped from the pit of the neck will fall between them. If the weight is put upon one foot alone, this line—representing what is called the centre of gravity—will fall across the middle of the arch of this foot. To attain stability weight must be evenly distributed around this imaginary vertical line. If we watch a child stooping to pick something off the floor, we shall notice that as his body projects forward at one end it projects backward at the other, the feet remaining stationary, so that his weight is still equal



on either side of his centre of gravity. If he merely bent forward from the waist he would fall on his face. When we stretch forward our arm to take some object which is just beyond our normal reach, we put out a hand or a leg behind us to 'keep our balance.' The ballet-dancer does this when she poises on one toe, her arms and body slanted forward, while her other leg points horizontally back. Her whole frame would fit within a triangle standing on its point—the supporting foot.

In the movements of stretching up, bending sideways, picking up weights, throwing and catching, the same law holds. If stability is to be retained, weight must be distributed evenly above the point of support. In the motion of catching a thrown ball, another factor comes into play, similar in its effect on the balance to a push with a stick—that is, the resistance of the hand to the impetus of the ball. The body must be prepared with just sufficient over-balance towards the object to overcome the push. If, while we stand steady on both feet, another person pushes against us with a pole, from the left, we lean slightly towards him and preserve our stability. If the pole breaks or he withdraws it suddenly, we fall towards him. The push is the equivalent of an added weight on the further side of our centre of gravity. So, if we held a weight in the right hand, and could swing it quickly out to arm's length as he withdraws his pole, we should not fall. We should have restored the balance.

We can carry a weight in very many varying ways, and each of these affects our posture differently. If the burden is carried in the hand, the body is thrown to the side away from it; if on the shoulders, the body is bent forward; if in the two arms, the body leans back against the forward pull. The best and most healthy way in which habitually to carry heavy weights is on the head, as do most native and unsophisticated races. When a heavy burden is carried on the head—provided that the muscles of the neck have been accustomed to the strain—most of it is actually supported by the piled-up bones of the spine, these in turn standing on the vertical long bones of the leg. The only thing the muscles are called upon to do is to keep these bones safely piled upon one another. They do very little, if any, of the real carrying of the burden. It is well known that this method of bearing weights gives a graceful carriage to the figure, as all the muscles of the body are in continual delicate counterplay, and develop in rhythm and harmony. Astonishing burdens can be borne on the head in this way, for week after week, by African native porters, men and

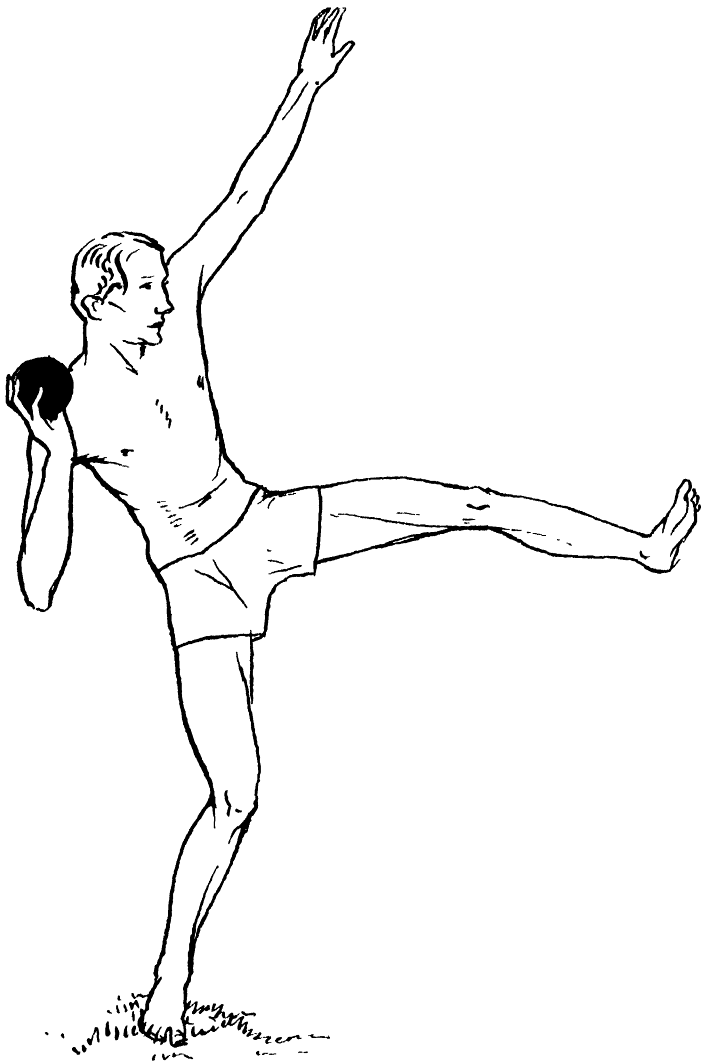
women; the method having the added advantage of leaving both hands free.

When weight is carried in the hands it is far easier to carry a given amount if it is divided into two equal parts, one for each hand. This disturbs only to a small extent the natural balance of the body; but it throws considerable strain on the muscles which secure the arms in their sockets, and those which hold up the 'shoulder girdle.' The backward pull of a heavy knapsack becomes very apparent when we take it off; when, for a minute or two, we feel as if we should fall forward.

So far, we have been considering the body only as standing upright. When we walk, we do so by putting the body out of equilibrium. Each step is, in fact, a frustrated fall. The weight is thrown forward, the body tilts slightly, and we bring the foot from which the weight has been lifted quickly to the front ready to receive it again. If, for any reason, the foot is caught and cannot get to the right place in time, the fall completes itself. When we are first acquiring the accomplishment of walking, the fall very frequently completes itself. The faster we walk, the less stable we are; running is a continuous fall. Only if we wish to stop do we put the supporting foot far enough in advance to establish equilibrium, so that the centre of gravity again falls between the points of support.

In a simple lever, the effect of the force or weight at the end away from the fulcrum or hinge is greatest when the lever is horizontal; in any other position it decreases. Thus, when we hold an object in the hand, the power required to raise it or to keep it at any height increases as the arm is moved away from the body. This can easily be proved by personal experiment. In unusual acts of balancing the two arms are used alternatively as weight adjusters, being raised and lowered in turn, their effect increasing and decreasing in ever-varying degree as the body sways. This is very clearly seen in a person walking a tight-rope or along the top of a fence or wall. The arms are in constant movement, up and down, towards and away from the body, to produce equilibrium. The fencer holds his left arm behind him, raised from the shoulder and the elbow, to help him to preserve his stability when thrusting and lunging. It is essential to him that his body shall be firmly balanced, yet free in its movements; so his left arm comes into play as a counter-weight. The drawing of a man 'putting the shot,' shows how useful is a movable weight on the far side of the centre of gravity. This man, though stability is essential to the heaving of the shot, yet finds his extended leg and foot so necessary a balance-adjuster that he poises precariously on the other only, in order to leave this one—what we might call his 'fluid counter-weight'—free. A few moments of experience in action—even in so familiar an action as walking—with

one arm tied to the side, will demonstrate the constant use we make of this leverage in our daily movements.



BALANCE. PUTTING THE SHOT

The human body changes very much in appearance during its first twenty-five years of life, much less during the remaining period. Within this period of growth the average individual increases in height from

twenty inches or so to between five feet and six feet; and in weight from about seven pounds to between eight and twelve stone. The bones and muscles of which our framework is composed do not grow at the same pace all the time, nor do they grow at the same pace all through the frame. The proportions of the baby are quite unlike those of the adult, and until growth is finally ended, between the ages of twenty and twenty-four or -five, these proportions are constantly changing. It is easy to tell the approximate age of a child from a full-length photograph even though no standard of size is given for comparison. The stage of development is shown in the child's proportions. In the usual way growth occurs rapidly during the first two years of life, then slows down until puberty is reached, when it makes another jump, afterwards gradually decreasing till it stops. The development and consequent

EXTERNAL EFFECT OF THE DEVELOPMENT OF THE NECK MUSCLES

thickening of the muscles influences the appearance of the external masses and contours of the body. An interesting example of this change is seen at the back of the neck, where the head is held erect by the great trapezius muscle, in conjunction with the muscles which hold up the spine itself. In the new-born baby this is so weak that the head cannot be held upright, but needs external support. The smallness of the muscle makes the back of the skull appear to project. As the child grows older the muscle strengthens and thickens, and begins to fill up the hollow line from skull to back. In a woman, the hollow at the back of the neck is still marked; in a man much less, till the series ends in the bulging neck of the boxer, whose muscle is super-developed by constant resistance and adaptation to blows on the head and face.

The shape of the figure is still further altered as it grows by the appearance of the sexual characteristics. The fuller breasts and rounder hips of the girl, with the difference in the relative width of hips and shoulders, make the distinction more and more marked. In men, as the muscles develop, the masses are flatter and harder than in women; the bony framework more apparent; and all the lines and curves of the figure are long and flat rather than round as in the girl. Differing physiological function calls for different muscular adaptation, and this again calls for slight adjustments throughout the whole mechanism.

Although it is not possible to alter the physical type peculiar to every

one of us, it is possible to develop that type to its fullest. It is the duty of every one of us to get the utmost out of the physical machine which has been given him; making sure that it works smoothly and with no interference, and that it is handled with the greatest economy of effort, so as to produce its results with ease and pleasure. To this end the human mechanism must be used and exercised. Only by use can it be kept in working order, so that it will perfectly fulfil the demands made on it. In the following chapters some hints will be given as to the methods of deliberate training and upkeep of the muscular structure of the body.

VII—EXERCISE AND HEALTH

PERHAPS the outstanding characteristic of the inventions of civilized man is a purposive or incidental saving of muscular effort. It is, of course, doubtful if primitive man sacrificed so large a part of his life to 'earning his living' as does average civilized man in this twentieth century. But the conditions in which his physical efforts were made, and also the strenuousness of such efforts, differed widely from those obtaining to-day. His activities were out-of-door; with the exception of agriculture and a few lesser industries, manual work is now chiefly carried on within four walls. The hygienic consequences of this have been profound. Another distinctive characteristic of contemporary organized industry is the increased monotony and lessened emotionalism involved. Hunting, gardening, fishing, which formed so large a part of the week's work of our early forbears, are now more and more looked upon as recreations for our hours of leisure. Like all other animals, we have minds and bodies which were created, or have evolved, in such ways that, in the 'natural' conditions of uncivilized life, work and health, pleasure and play were inseparably related. Pleasure, indeed, was but the signpost or index finger pointing to that which is desirable and health-giving. Few of us realize how partial, lopsided, and irregular has been his development since thinking and feeling man took a hand in the deliberate alteration of his environment and habits of life. Knowing by experience how pleasant is leisure after work, he has set before himself an ideal of workless leisure. Remembering how comforting is shelter from biting winds, and how generally desirable is cosy protection from cold after the heat of violent exercise, he has idealized and endeavoured to materialize an enclosed life, cut off, not only from the keen winds of winter, but from fresh air and sunshine also. As the artificiality of civilization increases, and established necessity stamps and seals our bondage to mistaken aims, events compel us from time to time either to retrace our steps or, at least, to restore some semblance of those earlier conditions we foolishly sought to escape. It is but comparatively lately that mechanical inventions have reached such a point as to enable many of us, and to compel many more, to live our lives with but the most trifling exercise of our bodies or of our minds. Much of the dreariest and most unpleasant work of the contemporary civilized world involves almost no muscular exercise,

and almost no thought. Practically none of the natural instincts and impulses of man is satisfied or stimulated thereby. Lives so spent are fundamentally unhealthy lives, even though their length, measured in years, may not be shortened. Outdoor work and outdoor play are the natural exercises of man; and the effects of such natural exercise are not just a matter of muscle development, or of breathing pure air, or of chest expansion, or of holding oneself in this or that position; important though, in many ways, all of these are. There is a unity between all parts of the body, and between the body and the mind, which the hygienist cannot disregard. We are apt to talk about our muscles and our nerves and our thoughts as if they had no necessary connection with each other. The intelligence needs exercising, so do the emotions, and so do the muscles. But it is a mistaken notion that would lead us to prescribe for ourselves or for others a sort of scholastic time-table, giving to each of these several educational procedures its appropriate hour—nine to ten, exercise the intellect; ten to eleven, the muscles; and so on. What we want is an intelligent, emotional exercising of the muscles, and a muscular exercising of the intellect and the emotions. A clumsy mover (if not structurally or pathologically handicapped) is apt to be a clumsy and muddled thinker; and, incidentally, to furnish the psychologists with an illustration of emotional stultification. Here we have the reason why games of skill, involving physical and mental activity in really intimate co-ordination, are so valuable. Much of the virtue of a public-school education is dependent on its games. It is, from the hygienic point of view, a pity that handicrafts and games of skill play so relatively small a part in the early education of the majority of our people. There could be no greater condemnation of the customary textbook system of education than the fact that it is so boring to all but a few exceptional girls and boys.

The cultivation of pleasurable hobbies—especially of outdoor hobbies—and of pleasurable handicrafts; participation in outdoor games involving some measure of skill and emotional collaboration, and the reduction of monotony in industry—even at the price of some sacrifice of the material gains of specialization: these things would of themselves restore to civilized man a very great many of the valuable things he has dropped by the wayside in his progress towards his goal. Quite apart from the specific cultural and aesthetic purposes with which the following chapter is more particularly concerned, general bodily, mental, and emotional exercise is essential, not only to the development of muscle and the attainment of bodily and mental agility, but also to the harmonious working of the whole intricate hierarchy of systems that make up the living creature, man.

Methods of Physical Education: Faults: Neglect of the Gymnasium

The education of civilized children must include instruction in physical exercise. For the most part, what may be called the British System of Physical Education is based upon the playing of games. Certain of these games are carried on by most boys as they reach adolescence, and proceed to young manhood, the national games of cricket and football—rugby and association—being the best known. Athletics—that is to say, competitive running, jumping, weight-putting, and other field sports—are hardly seriously undertaken by boys, the severe training required being impossible in schools, and, in any case, harmful to adolescents. Gymnastics has a place in all school curricula, but whereas in Northern European countries this forms the main part of the physical training of the young, in this country its influence upon the development of the growing man is becoming almost negligible. Although it is not desirable that the playing of our great national games should be discouraged in any way, it is certain that there are many cogent reasons for the reinstatement of the gymnasium as the fundamental factor in physical education.

The Swedish and German systems are the two main types of physical training by gymnastics. The employment of apparatus—consisting of the horizontal bar, the parallel bars, the vaulting horse with spring-board, rings, rope, trapeze—in the German system, while the Swedish system merely uses means of fixing parts of the body to aid in the performance of static exercises, indicates the difference between the methods. Both systems use mass drill of various kinds, leading up to advanced ground gymnastics, pyramid-building, and other intricate evolutions, the Swedish being carried out to word of command, and the German to example (imitation), time, or music.

THE CASE FOR GYMNASTICS.

We British do not like drill. It appears that most continental nations love it—or is it that the dominant type in each country loves drilling the weaker members of the community? But boys—and grown men—have respect for those who can perform feats of agility. Most of us have not had the chance to learn these fascinating exercises on the bars, rings, and rope, because, forsooth, they have been judged too dangerous by a majority of those responsible for our education. In the time at the disposal of the drill sergeant or gym instructor, the interesting part of ground gymnastics cannot be reached. The boys have little interest in 'stale' drill. The exercises have no value unless done with spirit, so that most of the time spent at drill is wasted. Young people could be stimulated to perform their drill with zest by the promise of instruction in real gymnastics, and the competitive

spirit would be stimulated by the reintroduction of Gym 'Eights,' Inter-school Contests, and the earning of Proficiency Badges. Some result would then be obtained by the drill exercises, and an improvement in deportment and physique realized. Many boys who waste time in the lower teams of cricket and football would benefit more from time spent in the gymnasium: if they were to show more talent for gymnastics than for games an inferiority complex might well be removed. Many boys who, through lack of weight or susceptibility to cold, are really unfit to play rugby football, might shine at gymnastics. It has been proved that with good instructors there is a trivial percentage of accidents in the gymnasium, and even if it is considered that there is some slight physical risk is not courage one of the finest moral qualities? The ability to perform instinctively some simple feat of agility will often save one from serious accident, even from death. If your 'head' for climbing has not been proved, how would you like to be cut off by the tide, and have to climb a cliff? Chased by a bull, can you vault a high gate or fence? There is no time to climb it! In motor accidents, during storms at sea, or in an unexpected fall, the trained gymnast will always 'come off' as lightly as possible.

It may have been mere coincidence that the final decline of gymnastics at our great Public Schools should have come simultaneously with the formation of the Junior Officers' Training Corps. It may be imagined, however, that many instructors might have been tempted to divert some of the hours allotted to physical drill to military drill, or rifle-cleaning. Many universities have no facilities for the practice of gymnastics, and often one finds that the mainstay of gymnastics nowadays is the working-man's club or institute.

The selection of drill exercises should be carefully made to avoid the chief faults of Swedish drill. Constrained, stiff positions and jerky, unnatural movements during drill must be varied by swinging, rhythmic exercises, which may be found described in French variations on the system. The attention and the body tire from tense waiting for commands. Indian clubs, swinging and dance-like exercises, bring graceful variation into drill. If the attention is allowed to tire slackness creeps in.

Points in Athletics: Training: The Heart and Circulation

The great athlete is born, but even he has also to be discovered and 'made.' The process of training must be gradual, but in some cases it may be safe to go faster than usual, this depending upon demonstrated capacity for standing more than the normal strain. Boys show an extraordinary power of endurance if their work is varied and they have frequent rests, but it is seldom safe to subject them to much acute

strain or continued effort in one direction. Such strain and effort call for great care in training, because of the danger of overworking the heart: every precaution must be taken to avoid this, particularly at the beginning of the season's training. In practice it is not safe to put the athlete to the utmost tests until close upon his first serious engagement. One mistake may injure the heart to such an extent that it may never recover. The aim in training for athletics should be to increase the output of energy so gradually that the heart becomes strengthened as more is demanded of it. If a breakdown occurs during training the athlete's heart remains dilated for days or weeks, whereas it should return to normal very shortly after the effort has ceased. This dilatation is caused by the increase in blood-pressure which follows the stimulus given to the blood-vessels by the strong action of the muscles, controlled through the nerves by the brain. The fibres of the heart-muscle respond to graduated increase of work put upon them by becoming both stronger and more elastic, and thus the walls of the heart become thicker. During violent exercise, as the poisons of exhaustion accumulate, the heart must be ready to put in its effort to supply more and more blood to the lungs for the elimination of carbonic acid, and the supplying of the body with clean blood. When the muscles are taut and healthy the blood-pressure will be found to be slightly raised; if the athlete becomes 'stale' his blood-pressure is lower than normal, and remains so until he recovers his 'form.' At the peak of a man's training he should be able to recover from the exhaustion of the supposed hardest distance—the quarter-mile—in about one hour and fifteen minutes, but much depends on circumstances. The finish of every race from the two hundred and twenty yards to the twenty-five miles may leave each winner equally 'exhausted,' according to measurement by scientific tests. But the latter distance could hardly be faced again on the same afternoon, whereas a short-distance runner might have to run two 'quarters' within an hour of each other, and might win them both.

CARE IN TRAINING.

It is held by some trainers that during preparation for the mile race, three-quarters of a mile should not be exceeded as a practice distance. Then the runner will have all his resources and reserves of strength to gamble with during the last quarter-mile. This method appears rather dangerous in that tactics must be varied to suit the case: the young runner might easily be 'bluffed' out of a win by a clever opponent dealing too softly with him during the bulk of the race: by all means spare the young runner in his preparation, but make sure that he knows what he can do before his first great test: after that is over the safety of this plan of training can be assured. In any case, the opinion that the distance to be trained over should be two hundred and twenty

yards short of the mile is probably to be accepted, but the runner must be coached to undertake 'spurts' at any time he is called upon to do so.

Long-distance running demands the strongest heart in the first place, yet it has been found that with careful and constant training—or, to put it more correctly, with both careful training and constant care—some of its exponents have been able to continue to run in championships longer than any other type of runner except the short-distance sprinter. Only young men can go 'all out' for distances over one hundred and twenty yards. Nothing can be 'eased' in races up to the quarter-mile distance, whereas the experienced 'distance' man learns to conserve his strength in many ways, particularly if he has perfected himself in muscle co-ordination by means of physical culture.

'ATHLETE'S HEART.'

Medical control of training by doctors skilled in the knowledge of the requirements demanded by various forms of athletics should be insisted upon by those in authority in the universities and athletic associations. Where are those sad cases of men who have had world-famous names in athletic circles dying suddenly or being chronic invalids on the brink of dissolution? They are seldom heard of nowadays. 'Athlete's heart' was a genuine bugbear, when many young men took pride in their ability to stand the exhaustion of a cross-country run, a weekly game of rugby football, even a boat-race, without undergoing thorough preparation, or before correct training methods were understood. Much is owed to those who have devoted so much of their time to research work upon this important subject; thanks to them, many lives have been saved. Associated conditions are against men spending too many years at competitive sports. Occasional 'turning out' is to be deprecated. The repeated abuse of a heart by threatened or real exhaustion caused by its owner rowing or running himself 'out' without the full training 'as laid down,' can only end in evil: it will be luck if such a course ends with nothing worse than a permanent 'weak heart.' The temptation to 'come back' is a great one. It comes to the very strong man, or the very famous athlete, who may have been head and shoulders above his contemporaries only a short while before, and who is probably contemptuous of the present opposition: the professional is tempted by a large 'purse'—the amateur by 'You are the only man who can possibly do it!' DO NOT DO IT. You may win—but it will cost you too much in the end. One season missed by the sprinter, the oarsman, the rugby player, or the boxer, if he be over twenty-five, may make it dangerous to resume, without a complete and searching training. Two years untrained, and the 'old form' cannot possibly be regained. Any exceptions to this rule

have been men who have lived the simplest of lives, and have been kept fit by means of constant hard physical work in the open air.

The age of twenty-five is the average which should not be exceeded by the amateur of the most strenuous sports. With great care he and the professional athlete may continue until thirty. For some years after this the boxer may possibly carry on, as his sport is in a category of its own owing to the compulsory three-minute rounds, and the peculiar combination of strength, skill, and experience required. Association football may safely be played for ten years longer than rugby, though speed of foot is certain to diminish gradually. Possibly, with professional training, the rugby player could keep his place for a year or two longer, but it is doubtful if his speed would serve for the positions demanding the powers of a sprinter, and he would be increasingly liable to injury. Hockey is often taken up by men who are just not able to continue their rugby career, but this game cannot be considered to be outside the 'strenuous' category. But many are the outlets for everyman's energy, apart from the strenuous games of youth. Cricket of by no means inferior quality is played by many middle-aged men: fifty—even sixty—years do not necessarily lay the active, healthy cricket enthusiast 'on the shelf'; although, of course, young men are needed for the continued strain—if not for the brilliant speed—of test matches with Australia. Bowling powers decline with years, but apart from certain positions in the field there is still a place in a county team for the potential 'centurion' of fifty! And there are other teams. Is golf 'an old man's game'? Yes. And it is also a young man's game. But surely we would rather our son's Saturday afternoons were spent slinging the oval ball from the base of a sweating 'scrum' than lying on his stomach studying putts. Tennis requires an athlete, and one who is in no mean training, to win at Wimbledon; but the skill of middle age, in any class but the highest, can lower youth's colours—and without danger. Repetition is invited by reference to swimming, climbing, dancing, riding, and many other common physical diversions too numerous to detail: practically all may be enjoyed until everyman takes the arm of his athletic grandson as he tells of his pristine prowess sixty years ago; but the desperate finish, the easy ascent of the Cairngorm as an afternoon stroll, or the clapping for the twentieth set of the foursome reel—these must be left to youth. Another factor in the consummation of our healthy, human desire to 'keep up our interest in games' is the theme of this chapter: 'KEEP FIT FOR YOUR AGE. HOW? BY KEEPING UP YOUR EXERCISES.'

Causes of Avoidable Deformities

Bones are not such rigid structures as is commonly supposed. Cartilage persists in certain parts of the body throughout life. Liga-

By courtesy of the Trustees of the British Museum

SICKROOM OF THE FOURTEENTH CENTURY

From a Bible History

ments can be stretched. Tendons are slightly elastic, and muscles may become permanently shortened. Movement at joints is impeded by the results of bad treatment of strains and sprains. The adult, therefore, needs to continue to be careful not to allow bad habits of posture to develop, and must guard against unconscious peculiarities of gait and the over-development of any group of muscles in relation to others. Children depend on the care and instruction of their parents and teachers for protection against the permanent results of incorrect posture and habits. 'Tics' develop with miraculous speed in imitative and subnormal children. 'Blinking,' jerking of the head, and palsy-like shaking of the limbs are habits far too commonly met with.

Defects of vision, which can be partially corrected by narrowing the eyes, lead to peering and poking the head forward. Astigmatism, often so slight as to be apparently negligible, is a frequent cause of the head being held tilted: this corrects the apparent sloping of the horizontal which is caused by the usual type of astigmatism, and may become so much of a habit that when an attempt is made to correct the ocular error with eyeglasses great difficulty is experienced by the individual concerned in readjusting his head-position. The shoulders follow the head, and only the tailor may discover that one is very slightly higher than the other.

Even very slight deafness in one ear may cause that extremely ugly habit of turning the head as if to direct the sounder ear towards the speaker, and it is amazingly difficult to break a child of this, although the original cause may have disappeared. It saves endless trouble if the causes of these habit-positions are recognized in good time as, apart from increasing difficulty in stopping the faulty movements, curvature of the spine is not long in following in their train.

Spinal curvature is also caused by faulty standing positions being adopted to ease the tired muscles of the back, and for this reason children should not be kept standing too long. The graceful position of rest while standing has nothing wrong with it provided that it is frequently reversed, and a good 'stretch' performed occasionally. The weight is borne almost completely by one leg and hip, the other leg being placed lightly on the ground outward and forward; the shoulder of the same side as the raised hip falls, and the other shoulder is raised; the spine taking the form of an even 'C' curve away from the supporting side. The ungraceful standing position with feet slightly apart, chest hollow, shoulders rounded, and stomach protruding, should never be adopted for more than a moment. Sitting with the hips tilted also produces this curve of the spine, and the vicious circle of tired spinal muscles, faulty positions of attempted rest, increasing curvature, and chronically tired and aching muscles is easily set going by many other 'bad-habit' positions. In the adult, spinal curvature has usually

persisted from childhood—or is caused by disease, and therefore is outside the scope of this section.

The correct standing posture, at 'attention,' for the child as for the adult, is with the head raised easily, with the chin drawn in; the chest raised, but not stuck out, the stomach and abdomen drawn in and flat in surface. The buttocks should not be protruded exaggeratedly, so as to hollow the back, and overtilt the pelvis, but should slope gently out from the loins. The knees should be straight, but not strained, and the inner line of the feet should point straight forward. Roughly speaking, if looked at in profile, a line dropped from the tip of the ear should pass the middle of the point of the shoulder; the middle of the hip-bone; the knees, and the middle of the great arch of the foot. When sitting at work, which is the time in which the greater proportion of childish postural faults are acquired, the upper part of the body should be carried in a straight line, perhaps tilted a little forward, if necessary, but never curved forward; the head, neck, and trunk being in one line. The buttocks should be firmly planted on the middle of the chair seat, with the back touching the back of the chair; not slouched forward to the front edge of the seat; and the feet should rest squarely but comfortably on the floor. If the chair is too high to permit this, a footstool or a small box should be put under the feet. The body should be kept square with the chair-back and the desk or table, not twisted. The seat of the chair should slope down very slightly from front to back, and it should be deep enough to come well under the knees.

During study hours it is good to have a break every hour or so, or whenever the subject is changed, and if the child cannot go out of doors for a quarter of an hour—which is the ideal—he should do some simple exercises to supple up the limbs and body and rest the muscles which have been taking the strain, before taking on his new task. These are especially useful in the winter-time, when the circulation must be kept going briskly; whilst, at the same time, 'going out' entails a certain amount of changing of the clothing, which may too thoroughly disturb the studious mood. Children can very easily be led to take a real interest in their own physical development, and so to co-operate intelligently in the building-up of a good and useful structural framework for their bodies.

Real deformity seldom afflicts the adult as a result of mere postural errors, unless severe stresses or weights are allowed to distort or press upon a yielding part of the body. Persistent adoption of really bad posture may, however, have permanently ill effects. In the adult the first step in dealing with such a case is the securing of the active co-operation of the subject. It is easy to rouse a hostility in his mind which may set up an opposition—often unknown to himself—to the treatment. He may genuinely believe himself to be unable to hold his body, or to

perform some movement, otherwise than as he does. This can usually be got over by persuading him to perform a different movement or series of movements, which, when carried out, will entail the making of the one desired. When this has happened once or twice, but not earlier, the subject's attention may be drawn to it.

During the process of correction of an habitual malposition it is, of course, most important to deal with the original cause; to remove or alter any circumstance which may have given rise to it, or be associated with it in the subject's mind; and then to re-educate the muscles so that their natural and unconscious response to a physical stimulus may be a correct instead of a faulty one. All remedial exercises should be purposive—that is, they should be consciously directed towards the replacing of the bad muscular habit by a good one. It is sometimes helpful actually to ask the patient deliberately to assume his faulty attitude—slouch, stoop, shoulder-twist, or bad foot-position; this often has an excellent effect in detaching it, so to speak, from him, so that he can study it dispassionately and recognize its difference from the ideal. Again, anything which will call his attention to a relapse into the bad habit is useful. Tightness across the shoulders from a stoop; pressure round the stomach and abdomen when sitting badly: things like these may be very useful in keeping one from falling back into error. If a bad habit can be made conscious instead of unconscious, it has gone a long way toward cure. But throughout all treatment, a real desire for improvement is the essential basis. The subject should be made to realize, through precept and example, what a difference he can make in himself and his appearance—how much better it is to hold oneself smartly and walk with a soldierly bearing, than to shamble along with stooping shoulders, hands in pockets, and flat feet. We all know the hunched shoulder of the student who constantly tucks his books into his armpit; the 'De Quincey' walk, nose leading and arms stationary at the sides; the 'single milk-pail' walk, one arm ungracefully swinging forward and outward, the other acting as a stiff pivot; the 'sheeny' walk, feet at 'quarter-to-two,' trousers flapping; the 'pouter-pigeon,' caused by corns or sore feet; and other gaits too numerous to catalogue. Another horror: why do so many women cultivate a walk characteristic of that of a screen 'vamp' descending upon her prey? And its counterpart, the clumsy lurch aped by the admirers of certain 'husky guys' of the films. No practising physical culturist, taught to know what his limbs are doing, could possibly make such an exhibition of himself as is seen countless times in a short walk through our streets. All careless habits, such as these, indicate lack of co-ordination, and lead to minor disabilities which could have been avoided.

CORRECT WAY OF WALKING.

In correct walking the toes should point almost straight forward, and the weight of the body be taken on the outside of the heel and foot, and the transverse arch formed at the base of the toes. There is no need to 'spring' obviously when rising on the forepart of the foot, but the step ought to show by its smartness that some muscular power is being used. The great toe is bent considerably as the other foot is placed on the ground, therefore any condition interfering with its free movement leads to a faulty action of the foot. A well-known Edinburgh surgeon, Professor Thomson, taught that the faculty of being able to raise the great toe perpendicularly to the ground is the most important function of the foot which we must continue to preserve: perform this action while your weight is on one foot, and you will see how the arch of the foot is emphasized, and feel the additional strength conferred. The large joint at the base of the great toe is exposed to injury from 'the hammer of the hard high road,' to deformity from deflection of the whole toe by narrow shoes with the wrong shape of inner edge—which ought to be straight—and to inflammation often associated with bunions and corns. Any of these painful things tempt the sufferer to 'take off' over the inside of the foot without raising it on the toes, and to do this it is necessary to walk with the foot pointing outward. It is then seen that the inside of the heel of the shoe is wearing, and, as it wears, the foot is allowed to assume an even worse position. At the same time the great Achilles tendon, which should stand out straight down the back of the ankle, begins to sag in a weak curve outward: the calf-muscles are working at a disadvantage, and become easily tired. If the owner of this foot, which is crying out for only a little attention, has to stand long, or carry heavy weights, he or she will probably attempt to use the bones of the foot and leg as props without the needful secondary support of the muscles, which have become lax and lost their tone. The great plantar ligaments in the sole of the foot become stretched, the keystone ankle bones are pushed down, and Nature's architecture collapses. Usually the condition, when it has just become fully developed, causes extreme discomfort, and medical or other advice is sought, but it is also one of the really amazing examples of a real deformity which can develop through simple carelessness without any pain whatsoever, and entirely without its being noticed by the person involved. Boys who are to become ploughmen are prone to flat-foot from the walk which they adopt as they follow their plough, placing their feet on each side of the furrow—their attention being on the horses and on keeping a straight course. As many of these lads grow to be fine big men, and often wish to enter the police force, this disability is an important one to guard against. The classical flat-footed policeman is called to our minds at once, his disability being caused by much standing in unwieldy boots:

'flatty' is a common nickname for one of this body of men. As the hard-worked veins of the leg with their poor valvular equipment depend largely for support on the tone of muscles, varicose veins are another likely disability to look for if flat feet have been noted.

Good exercises for the flat-footed are those which aim at strengthening the arch of the foot. The simplest of these consists in standing with the toes together and the feet parallel; then raising the body on tiptoe. Whilst rising, separate the heels as widely as possible, throwing the weight on the outer toes. Lower slowly to the original position. In the next exercise sit on a chair, with the feet pointing straight forward and parallel. Try to place the soles together by lifting the inner edges of the feet. In the next, while standing with the toes close together, rise slowly to tiptoe, and as slowly lower again. Then walk on tiptoe, with the weight on the outer edge of the toes. The last exercise is performed sitting; the bare feet are placed on a piece of cloth laid flat on the floor, and the cloth drawn into rolls by repeated curling of the toes; the big toe should be raised as high as possible at the beginning of each movement.

Remember how easily flat-foot develops: it wastes no time to walk on one's toes occasionally and exercise the feet and calf muscles. Remember what a nuisance lumbago is: 'straighten up' now and then, forcing back the shoulders—hollowing the vulnerable spot. You are addicted to 'pulling' when you have the chance of a game of golf: probably your right arm muscles are over exercised and developed—'change hands' frequently. If you are always out of breath after running up a short stair, try going up a little more slowly, but make sure that both legs are sharing the work equally, and try to put a certain amount of resistance against muscular action into the climb, breathing deeply several times as you come to the steps. The results of these experiments will probably please you; there are many more. Remember that 'being out of breath' often follows an effort because enough oxygen supply has not been laid in previously by taking a few deep breaths. We do not use, or exercise, our lungs nearly enough. It has been proved that pure oxygen has little effect upon the speed of recovery from exhaustion, but that an athlete can run twice as far without taking a breath if he has breathed pure oxygen for a few minutes.

Keep Fit All the Time

A man may, quite without fault on his part, be so situated that he is kept occupied during the whole day and nearly all the year round; time for recreation only being available during a short annual holiday. He may be a strong man, and impatient. He may be hustling up and down stairs, hurrying from one appointment to another, and apparently

keeping his muscular system fit by constant use. But this very active, alert, even athletic, man one day goes away for his holiday, straightway packs a tremendous amount of physical exercise into each hectic hour, and is overwhelmed with surprise when he has a 'heart attack' within a few days. He may not recognize this sudden feeling of tightness in the chest and struggle for breath, as a 'heart attack,' if he feels better in a short time; and he sets his teeth in the determination to continue his strenuous efforts to get as 'fit' as possible in the least possible time. The next attack may be a catastrophe, a 'shock' from cerebral haemorrhage or a fatal attack of angina pectoris. This series of events is merely an exaggeration of what happened quite normally and healthily when the same man entered upon 'training' when he was a youth. The important difference lies in the fact that his 'blood-pressure' was high before he began this too strenuous holiday. The further raising of the blood-pressure necessary to maintain an increased output of energy has resulted in overstrain of a heart already 'tired' by the year's work. This unfortunate man should have begun with a rest, and have taken things easily: then more exercise could have been allowed, but only gradually increasing day by day. The effects of the 'blood-pressure' had not been noticed—except the tired feeling—and the danger of increased strain had not been realized. This type of tragedy has become so common that one can hardly open a newspaper without reading of a similar case, or finding an article by a medical man upon the subject. If this busy man had kept his whole muscular system fit by means of daily exercises so that it would have kept going without so much effort, he might in the first place never have become so tired before his holiday, and secondly, not have collapsed when he attempted to perform his old feats without preparation. A common answer to the doctor, when he gives advice to both men and women to take, or give themselves, walking exercise of a certain distance every day in the open air, is: 'Don't I get enough exercise doing my housework? (or whatever the daily occupation may be).' A remarkable fact emerges from this question, and its answer—which latter is nearly always, 'No; not of the right sort!' Unless your mind is upon your work the results, so far as keeping 'in training' goes, are of little value. This is proved by everyday experience, for every woman who has a busy time with a home and family should be able to walk at least ten miles at three miles per hour without being exhausted. How many can? Our daily tasks are done mechanically. Unconsciously, and perfectly rightly, our bodies carry them out with the least possible effort. If, at any moment, one stopped to criticize one's position or attitude from an aesthetic or from a 'physical' viewpoint, one would probably mutter: 'Heavens! I must pull myself together!' And this is precisely what one should do, whereby many funny little habits would be noticed and checked.

VIII—CONCERNING DRESS

MAN is not the only animal that clothes itself artificially. The humble caddis worm constructs for itself a costume as elaborate in its way as any to be seen at a royal reception. But the dress of the caddis worm and of other tailoring animals is practically constant from generation to generation. No variations are introduced to meet new circumstances or new emotional demands. Man is the great experimenting animal; he is always trying something fresh and finding out whether it works—whether it satisfies him and his needs. There is good reason for assuming that man first appeared on the earth in a sub-tropical region; possibly not far from the supposed site of the Garden of Eden. At an early stage it is likely that he discovered means for protecting himself against the colder seasons even of that climate; though legend, which is often an embodiment of truth, has it that his earliest sartorial effort was rooted in a self-conscious perversion of modesty.

Whatever may be the early history of human dress, it is mainly through this artificiality that man has been enabled to wander over the whole area of the globe, and to settle down and thrive in regions far removed in space and in conditions from his original home. No other animal has so wide a geographical range. By means of clothing the human species has withstood conditions that would otherwise have proved lethal. Like every other experiment, and like every other invention of man, the adoption of dress has brought certain unanticipated troubles in its train. Fortunately, what man's ingenuity has devised it can usually amend. If he will but make full use of his knowledge and intelligence, he can derive from dress all the benefits which he set out to obtain; and, at the same time, avoid the many hygienic, aesthetic, and even moral evils that clothing has introduced into his life. Here we are mainly concerned with the hygienic problems. In order usefully to consider these, it is necessary briefly to analyse the ways in which clothes assist man in his search for health and liberty, and the physiological dangers attendant on this interference with the provisions that Nature has made.

Regarded mechanically, man can be looked upon as a conglomerate of machines, each one of which, like other machines, is constantly liberating or creating heat. It is the activity of the individual cells of the body, and the chemical processes in which they play a part, to which we owe the warmth of our blood and of our bodies. Had we no means

of cooling ourselves, and were we not possessed of elaborate machinery for this, we should become hotter and hotter with every minute of our lives. Our blood would boil, and our works would seize.

Heat Regulation of the Body

The cooling process is effected principally by means of the skin. Through it, as through all other parts of the body, blood is constantly flowing; and, according to the extent of its exposure and to the temperature of the air, the blood-heat is lowered. Our own sensations are an unreliable guide to the actual temperature of our blood. A feeling of cold is experienced when little blood is circulating through the skin; a feeling of warmth when the surface-flow is more generous. By no effort of will can we alter the size of our blood-vessels, or the relative flow of blood through any particular organ or tissue. This is regulated with great nicety by certain controlling mechanisms that are part of our inheritance. When the surrounding atmosphere is relatively warm, as also when, through active exercise, much heat is being produced within our bodies, the blood-vessels of the skin dilate so as to expose an increased amount of blood to the cooling influence of the air. When, on the contrary, the air itself is cold and we are at rest, these vessels contract, thus forcing the blood to flow in greater volume to the internal parts. There is, moreover, a supplemental provision for balancing excessive production of heat. Distributed over most of the surface of the body are small specialized collections of cells known as sweat glands, which have the power of abstracting water from the blood, and expelling it on to the surface of the skin, where it evaporates, and thus still further helps to cool the body. These are elementary facts which must be known to all of us from personal experience, though probably few of us have given much thought to them.

Hygienic Aspects of Dress

We are now in a position to consider some of the more important of the hygienic aspects of dress. Leaving aside all question of decency, which, after all, is mainly a matter of convention, the prime utilitarian purpose of clothing is to limit the loss of heat from the skin when the surrounding air is so cold as unduly to tax the vaso-motor controlling apparatus within us. Our clothes, therefore, should be bad conductors of heat—that is to say, they should allow heat to travel through them slowly. Experiment has shown that the texture of our garments is, in this matter of heat conductivity, more important than the nature of the fibre of which they are composed. Whether we are

anxious to prevent our animal warmth from escaping too rapidly on a cold day, or to hinder the heat of the sun from oppressing us on a very hot day, it is proved that a moderately open woven fabric is far more effective than a closely woven one. Flannel owes its reputation as a clothing material to the fact that it is so structured as to hold in its interstices minute particles of stationary air. Woollen blankets are bad conductors of heat for the same reason. But cotton wool is as effective a non-conductor as is animal wool, and cellular fabrics of cotton or of silk may be just as satisfactory clothing materials as are flannel or woollen ones.

The emanations from the skin are, however, to some extent excretory and, therefore, should have freedom to escape. This applies particularly to the secretions of the sweat glands. Any fabric, therefore, which is worn next the body should be readily absorbent as well as reasonably porous; otherwise, we are for all practical purposes draping ourselves in a rather unpleasant poultice. Moreover, our aim should be merely to supplement the regulative capacity of the skin, not to replace it; for all our faculties, physical and mental, soon lose their potency if they are disused. It is well known that people who habitually coddle and overdress themselves, fearing the slightest contact with the elements, and avoiding exposure to temperatures ever so slightly above or below the normal, are particularly prone to colds and to more serious illnesses, when they happen to encounter inclement weather conditions without their usual protection. They have, to use the common phrase, lost their power of reaction or adjustment.

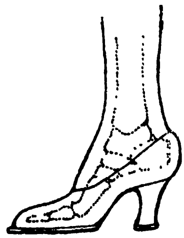
Our garments should not only be effective non-conductors of heat and ready transmitters of moisture, but they should also be as light in weight as is compatible with the circumstances of the season. We have been accustomed to cover ourselves with far too many superimposed layers. If the materials are wisely chosen two thicknesses of appropriate weight and substance should be adequate at most times and in most conditions that obtain in this country. Rain and biting wind may call for a suitable supplemental external covering, as also may enforced sedentariness in times of extreme cold. Then, again, all clothing should be reasonably loose, interfering as little as possible with the movements of the limbs or of the muscles of the abdomen, back, and chest. During two or three months of the British summer scarcely any clothing is called for if hygiene is the prime consideration; some protection from the sun's rays may be necessary during the middle of the day, since excess of sunlight can be nearly as harmful as its lack. Probably the best and most sensible hat for summer use both for men and for women is the Panama-grass hat; this is light and comfortable, and affords effective shade. It is difficult to understand why it is not more generally worn.

Boots and Shoes

The question of boots is a very important one from the point of view of health, as well as from that of comfort. Male fashions have in recent

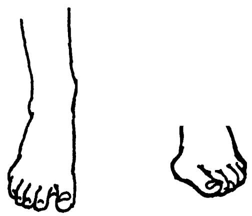
IMPRESS OF NORMAL FOOT

IMPRESS OF DISTORTED FOOT



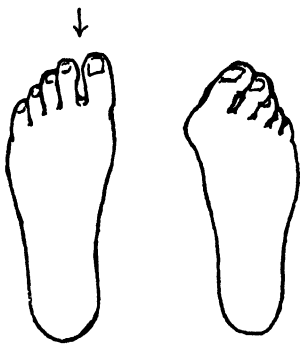
DISTURBANCE OF

CAUSED BY HIGH HEELS



UNDISTORTED FOOT

FOOT DISTORTED BY ILL FITTING SHOE



EFFECT OF HIGH HEELS IN THROWING THE BODY OUT OF BALANCE

years become more sensible; but women's footwear remains, all too often, at the top of absurdity and discomfort. There is really nothing to be said for the high heel or the narrow toe; both are ugly and deforming. Not a small proportion of the chronic ills from which women,

not afflicted with any particular disease, suffer, may be traced to the ridiculous shoes which they have allowed custom to impose on them. The foot is very subtly structured to bear the weight of the body in movement and at rest. To allow for the varying line of stress, the bones which compose its arches are wonderfully arranged and jointed together. Narrow and ill-shaped shoes nullify the whole of this ingenuity. Commonly these living and mobile structures are treated as though they were mere dead plaster bases capable of being moulded according to the whims of the designers of fashion plates.

A sensible boot or shoe should be so shaped as to have a practically straight inner sole line from heel to the tip of the big toe. The front of the shoe should be as wide as the toes when spread at their widest. The heel should not be more than about an inch in height, and should be as broad as the human heel that is to rest on it. The length should be such as to allow for the fullest extension of the toes when the body, bearing a substantial weight in addition, such as a well-filled suit-case, is supported by the feet. In the case of shoes as distinct from boots, the side should be cut low enough to allow free action of the ankle. The leather, or other material, of which the boot or shoe is made should be reasonably pliant. The fitting round the arch, instep, and back of the heel should be fairly snug. In another section of this book are described certain foot deformities due to the wearing of ill-fitting and ill-constructed shoes; and some advice is given as to the best way of remedying these often serious ills.

Nudism

Perhaps a word should be said about a movement that has recently attained a good deal of notoriety, the nudity movement. It is probably difficult for most people to contemplate this development with an impartial mind. It is doubtful if, in this country, except possibly for a few weeks in the year, nudity is hygienically practicable. On moral and aesthetic grounds this is probably regrettable. The possibility of covering up our misshapenness with clothing is apt to lead to aesthetic and physical slovenliness, and to lack of wholesome pride; whilst one can only regret that man, uniquely among the animals, has developed a sense of shame relative to the body with which he has been endowed. The line between prudery and pruriency is a very tenuous one. In the long run we shall find that the dress which is in the widest sense most hygienically fitting is also the most aesthetically and morally satisfying.

IX—THE HOUSE

Man is the supreme home-maker. Probably in no other species does one find the home such a definite centre of the activities of life, and the family such a definite unit. Perhaps this is because man tends to permanent mating, his family is relatively small, and his offspring take many years to reach maturity. Perhaps because, his natural protections, apart from his wits, being few, he is forced to give more time and thought to the elaboration of his dwelling, which therefore means more to him.

One does, however, find the home-making instinct in many animals. The need to have a regular resting place, which shall form a protection from enemies and from the elements, is felt by many species, as it was by early man. Some animals show great ingenuity in choosing and adapting suitable homes. Many have the instinct to return to the familiar spot, to have a permanent resting place; although with some the home is simply a temporary dwelling for the short time required to nurse the offspring through their brief youth. In many birds' nests we find superb craftsmanship and much beauty, as well as safety and comfort. In the beehive and the ant-hill are manifest great communal activity in construction, and specialization in use of different parts of the home. But man, with his adaptability and his mechanical ingenuity, can surpass all these. As civilization advances his home becomes more complex and more suited to local circumstances.

Nowadays our occupations are specialized, and few of us build our own homes. But we plan them or choose them, and the interest remains. The services of a variety of expert workers greatly increase our scope in home-making, and civilization is ever adding to our choice of material and to our knowledge of utilizable means. Through our gregarious instincts and the needs of a specialized life most of us tend to live in communities, but the home and the family remain essential units.

Although elaboration may make for increase of comfort, this is probably not the key to man's success as a home-maker. Our greatest achievement is in suiting our homes to our necessities. Like the snail, the sailor or the gipsy can take his home with him on his wanderings. The arctic snow-hut is as suited to its conditions as are the flimsy houses of Japan, a land of earthquakes. The Englishman in the tropics will build a house very different from those at home; for the sun will shine on it from every point of the compass at some time of the year. He must protect himself from great heat, fierce winds, and

torrential rain, and must provide against the cold nights which often follow hot days.

Few of us have complete freedom to build our houses where we wish, or to plan them as we please. Our economic position, our work, and many other considerations tie us down. So it is important to realize that suitability, rather than spaciousness or elaboration, is the essential element in successful home-making. So many factors come into play that one can rarely hope to achieve the ideal home, but we can at least give consideration to certain things which are essential, and to other things which are desirable, from the point of view of good health. These principles are applicable to the small flat and the cottage, as well as to the mansion.

Our houses are the combined result of many factors. The taste and planning provided by the architect are limited on the one hand by financial consideration, and on the other by the constructive abilities of the builder and the materials which he can supply. Latterly the hygienist has taken a hand; while the voice of the housewife has become more insistent, for, with less space and less service, the practical problems of storage and of easy working become more important. Fashion and convention also play a part, which may be a restricting one.

Here we are primarily concerned with health, but we must not forget that beauty, comfort, and the saving of labour have their claims, and that they too have a health as well as an aesthetic value. All these must be considered when the architect, the builder, and the hygienist pool their knowledge and their resources to construct the ideal healthy home. Each must contribute his quota in fair proportion, not overshadowing the demands of the others. Though past experience and sound tradition cannot in practice be safely ignored, modern life and modern knowledge call for a restatement of the problem, and a loosening of the bonds of convention.

The home of the cave-dweller gave him some degree of security and shelter from the rain and the cold winds. It was a place where he might keep his goods and store his food, and where his young might be reared. We have learned to build our caves where we will, and to elaborate them, but their main purpose is much the same. Our stock of goods and chattels has increased, and domestic labour has become more complex, so that we use and inhabit our houses more. Unfortunately the protection we have secured has brought some evils in its train. In depending on this protection we have to some extent lost our natural powers of reacting to extremes of weather and temperature. In excluding the wind we have excluded much of the sunlight which is a tonic and an aid to our bodily processes and development. In seeking warmth we keep out fresh air. We herd too closely together. Many of us live in houses which through bad construction or through age have

become damp and insanitary. Thus our 'protecting houses' are the cause of much disease. Damp houses have a definite association with rheumatism, as has overcrowding with many infectious diseases. The dry, still, vitiated atmosphere of unventilated rooms makes our mucous membranes particularly vulnerable to infective organisms. Overcrowding makes infection easy. The sudden transition from overheated air to the cold outside may, with our slowed-down reactions, give the chill which precipitates disease. Lack of air and sun brings debility and fatigue, and lowers our resistance. So, although we cannot now do without houses, they must be healthy ones.

Our houses vary so much that they can hardly be considered in detail, even from the health point of view alone. We can only establish a few general principles, and consider a few defects that should be avoided. These principles must be applied as far as circumstances permit, whether the house be large or small, whether we are building a new house or adapting an old one. In every case we must bear in mind that our houses must be suited to healthy and comfortable life the whole year round. We do not here have the extremes of heat and cold that exist in many countries, but our climate varies considerably, and we are subject to marked changes from day to day.

Site and Foundations

In building or choosing a house one should consider the site and the soil on which it is built. All soil contains much air in its upper levels, and below that water. The ground water is the accumulated rainfall, the water percolating down through the soil until it comes to an impervious layer, on which it rests or, more usually, flows. This ground water naturally follows the same laws as water elsewhere, finding its level, and flowing down subterranean slopes of impervious strata to any available outlet. We may imagine a series of lakes, streams, and rivers in the ground beneath us, and we must remember the possibility of stagnant pools where there are hollows in the impervious layer below. The height of the level of the ground water depends on the depth below the surface at which the impermeable layer lies, and on the rate at which the water can flow away down its natural gradients. In marsh land the ground water comes actually to the surface, and in alluvial land it tends to be very near it. Such soils are naturally unsuitable for house building, and if used at all, piles must be sunk or arches built on which to place the foundations.

As the ground water consists of accumulations of so much of the rainfall as has not evaporated from the surface or become absorbed by vegetation, its level varies with the seasons. In some places a connection appears to have been established between variations in its level

and the occurrence of epidemics of enteric fever and other diseases. Certainly too high a level of ground water is prejudicial to health. A high level of five feet below the surface is dangerous: a high-level mark of about fifteen feet down might be considered satisfactory.

Above the water itself there is still moisture, and the interstices of the higher soil are filled by the ground air. As the water level changes the quantity of ground air varies, as it is continually being driven out of the soil or being drawn in. The quantity also varies with the nature of the soil; loose permeable soils such as sand and gravel containing much ground air.

Surface soil has been called a natural laboratory. Much organic matter drains into it or is washed down by the rain. Vegetable decay is always occurring. Every kind of soil contains countless bacteria, many of which are engaged in aiding the processes of decomposition; others take part in the forming and storing of nitrogen; and these chemical processes cannot take place without the liberation of gases and other effluvia. The ground air, therefore, contains much moisture, and carries emanations from decomposing material, varying in amount with the purity of the soil. 'Made soil,' the result of filling up land by the dumping of rubbish and refuse, has naturally many impurities in its ground air, and such soil is quite unsuitable for a housing site.

Speaking generally, one should choose for house-building a situation that is warm, dry, fairly elevated, and on a gentle slope. Trees form a useful shelter from prevailing winds, but should not be too near the house, as they exclude sunlight and promote dampness and air stagnation. The soil should be dry and porous, with a low water level and reasonably pure ground air. In this country gravel and sand, being both warm and porous, are the best soil. They contain much air, however, so they become unsuitable if there is much pollution. Chalk is porous, but somewhat cold. Clay is both cold and damp, and with it there is much shrinking and expanding, sometimes with cracking of the surface soil. Buildings should not be built on two different kinds of soil, as these react differently to atmospheric changes, and subsidences may occur.

Steps must be taken to prevent water and ground air from entering a house. When a house is heated, particularly in winter, when the surrounding soil may be frostbound, there tends to be a constant inward and upward current of ground air, impure and bearing much moisture into the house. The whole of the foundations must, therefore, be covered with an impermeable layer, consisting usually of at least six inches of concrete. Paving laid round the outside walls is also advisable. If there are no watertight cellars beneath the house the lowest floor should be two feet above ground level, the space below being well ventilated.

The unhealthiness of damp houses is a matter of common knowledge. To prevent the passage of water from the soil one must protect the walls as well as the floor, for all our ordinary building materials are capable of conveying water. It is usual to build the walls with a damp-proof course, which forms a watertight layer a little above ground level. This may be made of slate embedded in cement, or of a row of special glazed and impervious bricks, which are usually ventilated. In the same way steps must be taken to protect the outside of the wall from damp at any point where it is in contact with the soil. The walls themselves must be kept weatherproof, brickwork being pointed and woodwork painted whenever necessary. Very exposed walls may require a waterproof coating of some material such as Portland cement. Defective roofs and rain-water pipes and gutters are a frequent cause of dampness.

Sanitation

It is difficult for us now to realize the many dangers to health that have been abolished by modern sanitation. Water-carried sanitation is almost universal, at any rate, in urban areas, and the cesspool, the pail-closet, and the open sewer have largely disappeared. The technical side of sanitary work must be left to the expert. His aim is to arrange that waste matter shall be removed from the house as cleanly and as rapidly as possible, to be treated suitably elsewhere. For a long time our system aimed at the assembling of all sanitary appliances as near an external wall as was convenient, so that all pipes passed outisde the house as soon as possible. Waste, soil, and rain-water pipes were arranged on separate systems, and waste and soil pipes were trapped at their source and at their entry to the sewer. In recent years some modification of our plans has been necessary. The demand for individual sanitary accommodation has increased greatly, and it has been found that in large houses, hotels, and blocks of flats the old system of pipes and intercepting chambers was complex and very costly, as well as difficult to accommodate without spoiling the building. As a result there is now a tendency to revert to a one-pipe system, and to permit more internal drainage. Modern artificial ventilation also makes possible the provision of internal lavatories in some cases, releasing the external wall space once occupied by these rooms. We rely nowadays on sound construction and on good flushing and effective ventilation of all pipes. Traps at the source are still necessary to cut off the drain from the room, but modern architects simplify drainage by cutting out many of the old-style intercepting chambers.

The wider use of coke stoves for water heating is facilitating the disposal of household refuse. If such stoves are properly used there is no refuse liable to decomposition which cannot be burnt. As a result,

the dustbin, so often to be found outside the kitchen window, need no longer be a source of smell and an attraction for flies. Incidentally there is a decrease in the demand for refuse removal, a costly public service.

The use of refrigerators greatly helps in the hygienic storage of food. Increased knowledge of the dangers of infection or contamination of food has made us more fastidious with regard to its clean handling and its protection from dust and flies. Summer diarrhoea in children, at one time a frequent cause of infant mortality, has become rarer and rarer as our standards in food protection have risen.

VENTILATION

It has been said that one of the purposes of our house is to provide us with warmth beyond that which we generate ourselves. This we must arrange with care, lest in providing warmth we deprive ourselves of the fresh air which is so important to health.

Free air is, normally, very constant in its composition, its main constituents being oxygen, 20·9 %; nitrogen, 78 %; and carbon dioxide, 0·03 %. In towns stagnant patches exist where there is little air movement, and as much as 0·06 % of carbon dioxide may be found. In such spots back-to-back houses or houses in courts and narrow alleys may be taking in stagnant air which is already impure. Vitiation of the air inside houses occurs through the expiration of carbon dioxide by people and animals. Combustion also adds carbon dioxide to the air and uses up oxygen. Plants take up the carbon dioxide and give out oxygen in sunlight, but at night the process is reversed, so that they too may cause vitiation of the atmosphere of a room.

The percentage of carbon dioxide in a room can be used as an index of the amount of pollution. If it reaches 0·06 the atmosphere has a feeling of stuffiness that is appreciable to our senses. But it is not this gas which is harmful to health. Even in a badly overcrowded room the percentage of carbon dioxide is rarely great enough to cause any serious effect on health; indeed, excess of this gas stimulates breathing, so that we easily maintain our supply of oxygen by taking in more air. The feelings of fatigue, depression, restlessness, and perhaps headache which arise in an impure atmosphere appear to be due to the absence of movement in the air. An electric fan moving even vitiated air gives a sense of relief. Air movement lowers the temperature of the room, and carries off moisture and the emanations of our bodies; and by stimulating breathing and aiding evaporation from the skin it removes the feeling of stuffiness.

The purpose of ventilation, then, is not only to bring a constant supply of fresh air, but to do so in such a way that there is, in the room, constant movement of volumes of air.

Movement of the air within our houses is caused in three principal ways. First, the gases in the air follow natural laws which cause their diffusion until the mixture in a given volume of air is similar to that in the surrounding atmosphere. Next, wind acts on the air in a house directly by blowing into apertures, and indirectly by blowing across a chimney pot or open window. In this second case a process of aspiration may draw out the internal air. Thirdly, the difference in weight of volumes of air causes their movement. Heated air expands, it therefore grows lighter, and rises, being replaced by cooler air. As our heating systems may cause both air pollution and air movement they must be considered in relation to ventilation.

The amount of air which we inhale varies with our age, our size, and the work which we happen to be doing. Various scales have been worked out as to the amount of air space per person required in differing circumstances. Perhaps four hundred cubic feet per person in rooms used both day and night, and three hundred cubic feet in rooms used only for sleeping, may be taken as a minimum. This applies to rooms where efficient ventilation exists, so that the atmosphere of the room can be completely replaced three times in an hour. In calculating air space for official purposes it is usual to omit the space above twelve feet. In fact, the changing of the atmosphere is more important than the actual room space; for the air in even a large room would soon become vitiated without ventilation. It is, however, easier to ventilate a large room without the occupants becoming too conscious of the air movements. If our rooms are small we must pay particular attention to the arrangement of our ventilation, as too frequent changes of the room-atmosphere, when the incoming air is cold, are apt to be uncomfortable.

For efficient ventilation we must have a fresh-air inlet, and an outlet for the removal of impure air, of which the latter is the more important. If the used air is removed it will always be replaced. Air passes in under doors, between floor boards, round windows, and even through our walls. But this may be dusty air or impure air from other rooms, and there should be a definite entrance for fresh air from outside.

One of the best agents for the removal of impure air is the open coal fire. Above this a column of hot air is continually passing up the chimney, and air is drawn from the room to replace it. Those systems of artificial ventilation which depend on the extraction of used air from buildings, rather than the driving in of fresh air, act on the same principle as the coal fire.

The best inlet for natural ventilation is, of course, the open window. This should be well open. If air is being removed it will be replaced, and a small opening simply means a fiercer and narrower stream of cold air. If the opening is quite insufficient there will probably be a draught, perhaps from under the door. 'Draughts,' as distinct from

the slow and steady diffusion of fresh air, are harmful and unpleasant. They cause excessive cooling of single parts of the body, instead of the body as a whole, and such partial chills lower resistance. Where the inlet to a room is larger than the outlet there is less likelihood of draughts. These are also avoided if the incoming air is able to circulate freely through the room, instead of passing in a direct current from inlet to outlet. This also prevents the occurrence of stagnant corners in the room.

One must always remember that hot air rises, cold air falls. The outlet, therefore, should be as high as possible. Theoretically the inlet should be very low, but when the incoming air is cold it is probably best to let it in a little above head level, and direct it upwards, to avoid discomfort. It will come in contact with the hot air above and fall to a lower level.

Differing methods of heating may give warmth by radiation, as in the coal fire; by convection, as in the hot-water radiator; or by both methods. Radiation of heat causes the gradual spread of warmth over the surfaces of objects in the room; convection heats volumes of air which themselves pass about it. Radiators and hot-pipes cause air movement, but do nothing to remove impure air. Heating apparatus which depends on combustion should be provided with a flue to remove waste products, which flue will also act as an air remover. As has been said, the open coal fire is the best of these ventilators. It is an agreeable form of heating, but a somewhat wasteful one, for much of the warmth is lost up the chimney. Probably none of our ways of warming ourselves is injurious to health if in our search for cosiness we do not forget the need for ventilation. Those ways which depend on convection may make the atmosphere too dry, while overheating has a fatiguing and unhealthy effect. 60° F. is a good average room-temperature.

The success of the open-air treatment of tuberculosis and other diseases has done much to dispel the old fear of fresh air, and especially of night air. Many people have proved for themselves in the course of treatment that one can, with benefit to health, sleep on a balcony or veranda, or in a garden shelter. Warm coverings and protection from rain are, of course, necessary. There is no reason why this treatment should be reserved for the sick, and we may well consider whether some such arrangement is practicable for ourselves. Even where it is not we can at least all throw our bedroom windows wide open when we go to bed.

At various points in this book we have made reference to the importance of sunlight to health, and we must remember this when considering the selection of our ideal home. Good large windows are very desirable, and often the addition of a bow window will make all the difference to a room both in looks and in health. An over-large

area of window glass may be blamed for coldness in winter and excessive heat in summer, but we must make sure that the windows are big enough, and that they are so placed as to permit of real penetration of the room by light. And having got good windows, we must not, in our desire for privacy or for decoration, shroud them so completely that they are useless. It is quite possible to secure privacy with a minimum of light exclusion.

In England the north and north-east aspects of a house are cold, the southern aspects warm. The north-west and south-west aspects are usually windy, and there may be driving rain from the south-west. The south-east aspect is dry and mild. Ideally, one would place one's living-room facing south-east, one's bedrooms east to get the morning sun, one's larder on the cold north side. In practice this may not be easy. Rooms cannot be isolated, but must be taken as a part of the house as a whole. All the bedrooms can hardly face east. The room to the south-east may not be in other respects the most suitable living-room. Yet there is no doubt that we do tend to be tied down by certain conventional arrangements of rooms, and we may consider it worth while in certain cases to avoid these traditional plannings. In too many of our streets the houses all conform to one type while it is quite obvious that the arrangement which is best in one house will be wrong in the similar building facing it across the street.

Cleanliness

Most of us in these days have smaller houses and less domestic help than had our grandparents, and we must learn to adapt our houses accordingly. Fortunately our modern taste goes in the direction of smaller and simpler furniture. In a small house, one must conserve what space one has, and avoid all obstruction to light and to moving air. Large ornate pieces of furniture collect dust, and make more labour; heavy curtains and hangings shut out light and air. Perhaps their only advantage is that they deaden sound, of which there is plenty these days.

Cleanliness has real hygienic value, and an orderly and well managed home brings rest and contentment to its occupants. But there is no reason why these things should not be won as easily as may be. The modern housewife may have little help, she may have outside work, and she will certainly have outside interests. Let us lighten her labours as much as we can, and try to save her from weary drudgery. Let us cut out corners and crevices in our house construction, and give her surfaces that are easily cleaned, and implements which keep her from her knees. Every labour-saving device is an aid to health, and we should think kindly of vacuum cleaners and stainless metal and running

hot water in the tap. We should be glad that there are fewer oil lamps and cumbrous kitchen ranges, and that the chemist and the mechanical engineer have supplied a hundred little aids that make housework easier and quicker, without being less efficient.

Town Planning

We must not fail to see the wood for the trees. Just as we must plan our rooms so that they fit in with the rest of the house, so we must, in urban districts, think of our houses in relation to the town as a whole. In recent years we have come to hear much of 'town planning,' but the idea is probably older than the term.

Though many towns look as if their development had been entirely haphazard, this has seldom been the case. The grouping of houses is controlled by topographical considerations, and by the attractions of various centres. The civic buildings, the harbours, the market place, and the railway centre make a focus for the commercial classes; just as the university, the law courts, and the cathedral do for certain professional groups. There is a tendency for certain trades and callings to congregate together, as—to take London—in various parts of the City or in Harley Street. The convenience of rapid communication and of working in a district known to be devoted to the particular occupation outweighs the disadvantage of competition at close quarters; and residences in towns bear some relation to these business groupings. The wealthy build their houses in the most desirable district; in this country, frequently the west end of a town.

The growth of public services has had an effect on the arrangement of our houses. The prospective builder must consider the position of roads, and the possibility of benefiting by water, lighting, and sanitary undertakings at reasonable cost. Large crowded areas demand parks and open spaces. The creation of new roads or the erection of important buildings is more readily undertaken where ground is cheap, and so poor-class property which has heretofore occupied it is swept away.

We now plan ahead for these improvements, instead of letting them arise as by-products of other events. We try to think of a town or a district as a whole, and to preserve or improve its amenities. We try to clear unhealthy areas. We regulate offensive trades or banish them from our towns. We control the height and the nature of buildings so that other residents are protected. We make broad roads, which not only help our increasing traffic problem but make passages for air currents, and strips of sunlight. We look ahead at our ever-expanding towns and plan parks and green belts among them. And thus we may hope to obtain healthy towns as well as healthy houses.

X—THE TOWNSMAN

THE artificial circumstances of life surrounding the town-dweller offer some special problems with which his country cousin need not concern himself. These problems may be conveniently discussed under the heading of the special sense organs: skin, eyes, nose, ears, mouth; for it is these organs that bear the stress, as it were, of the change from natural and even primitive surroundings to those in which all the modern mechanical miracles are treated as a matter of course. The townsman reacts even to weather conditions in a different manner from that in which the agriculturist reacts; his days are spent indoors instead of in the open, and his nights, even when he is middle-class and steady-going, do not invariably conform to the early-to-bed rule. The townsman can keep well if he will, but it is not so easy for him as it is for the plowman. It is the details of some of the points of difference that we now proceed to discuss.

CARE OF THE SKIN

The skin or integument, the largest organ of the body, combines the functions of ordinary sensation, protection, secretion, heat regulation, and, to some extent, respiration. For the due performance of these important functions it is essential that the skin be kept clean. In the country it keeps itself clean; in the town the atmosphere is laden with dirt particles which penetrate even heavy clothing and clog the pores. The skin of the town-dweller requires to be kept in training. In health it contracts under cold influences and relaxes under warm. The rapid transition from an overheated atmosphere to a very cold one, as may occur in coming out of a theatre, very easily leads to an undue loss of heat unless the skin is taught to react quickly to heat and cold. In a general way this is best done by wearing as few clothes as possible, and by frequent cold, and occasional hot, baths. It is a great mistake to coddle the skin. It should be kept clean and thoroughly toned up.

EXERCISE

The secretion of moisture from the skin, called sweating or perspiration, though primarily a measure of heat regulation, is a depurative procedure of great value. It is important to realize that this purifying effect is more marked when the perspiration is the result of muscular activity than when it comes from externally applied heat, as in a Turkish bath. The muscles in contracting burn up the poisons and excrete the ashes partly through the skin. The active countryman, as a rule, expects to perspire when he takes exercise, but the townsman does not. The countryman is always prepared to sweat, whereas the townsman is

obliged to dress specially for the occasion. In his ordinary formal business attire, he is forced to avoid perspiration; it is only when he has donned flannels and an open-necked shirt that he feels prepared. How to get exercise which falls short of exciting perspiration is always a problem for the town-dweller, and its solution must always be an individual matter. If a man lives at some distance from his office it is a good plan to try to walk some of the way home. Some people try walking to the office, but they soon give it up because of the obvious inconveniences of arriving wet, or hot and tired, against which it is not possible to provide. The walk home has no such drawbacks, because a change of clothes can always be effected. 'Physical jerks,' as they are called, have many merits for town-dwellers of both sexes. There are many systems on the market; the best of them lay special stress upon the exercise and development of the muscles of the abdomen and lower limbs. The muscles of the legs can, and should, be kept in good order by walking and various games. It is clear that man would not have been provided with such large and powerful muscles as those which adorn his lower extremities had not Nature intended them to be fully employed, and this, for most townsmen, is not an easy matter.

The importance of well developed abdominal muscles may be realized from the fact that these muscles constitute the only barrier to the sagging downwards and forwards of the organs contained within the abdominal cavity. This ugly dislocation is of such common occurrence among townspeople and is attended by such disastrous results, physiologically and aesthetically, that ingenuity has been exhausted in the invention of belts and supports and corsets of every shape and material. When such supports become necessary it is doubtless well to appeal to them. But they never ought to be necessary; for they constitute a confession on the part of the wearer that he or she has lived very unhygienically. To restore a lax and protuberant abdomen to normal proportions is a matter of diet as well as exercise: to preserve it from becoming lax and protuberant is usually a matter of exercise alone. The best outdoor exercises with a special effect upon the abdominal muscles are horse-riding and boating, and these are not as a rule easily accessible to town-dwellers. A good system of physical jerks with special appeal to the abdominal muscles ought therefore to be cultivated and persevered with—dull as such systems admittedly are—by all those condemned to town life.

Exercise is important not only to the general well-being; it has particular applications. It is, for example, well to remember that the stiffness of joints which so often comes with middle age is due largely to want of exercise. If muscles are not used, then joints are not moved, and if joints are allowed to remain inactive a species of rust collects about them, limiting movement and causing the pain which people call rheumatism. Also, it is to be remembered that muscular

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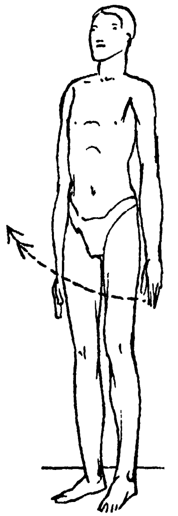
contraction is one of the forces by means of which the circulation of the blood is carried on. The veins of the trunk and lower limbs are obliged to return the blood towards the heart against the force of gravity, and this they cannot do efficiently unless they have the support and assistance of well developed and well exercised muscles.

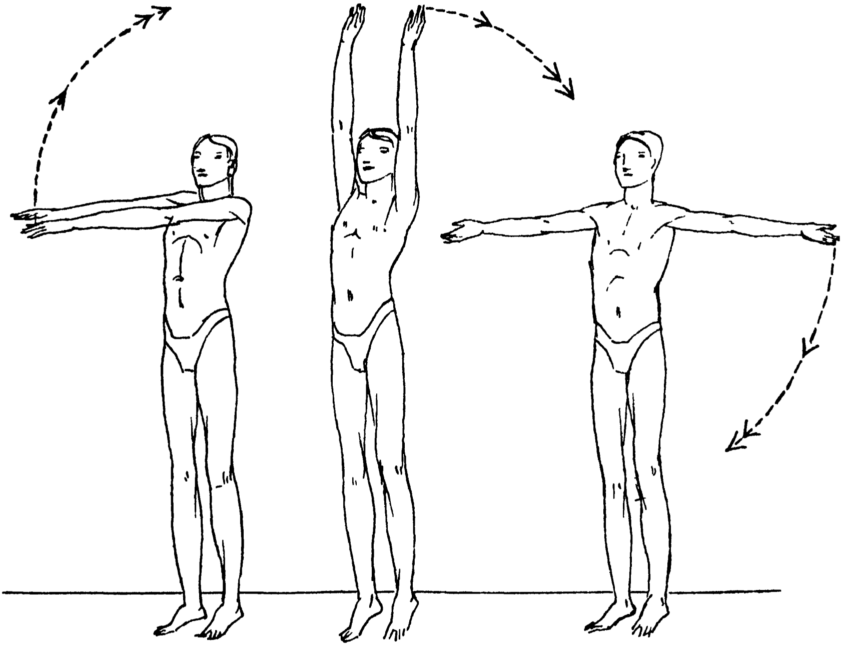


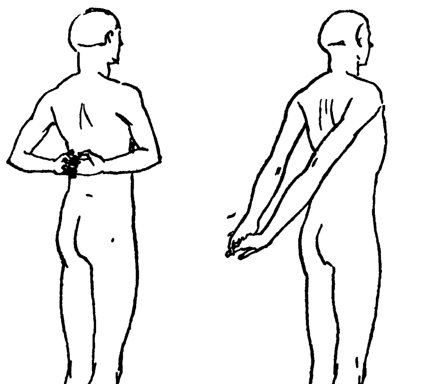
The exercises illustrated here make up a set suitable for any one who lives a sedentary, town life, and wishes to keep himself in reasonably fit physical condition. They should be performed in the morning, preferably while the exerciser is unclothed, and, whenever possible, with the windows open. Before the morning bath is a good time to do them; and they should never be skipped, even though lack of time may sometimes cut them down. It is better to go through the routine, lessening the number of times given to each exercise, than to leave any of them out entirely.

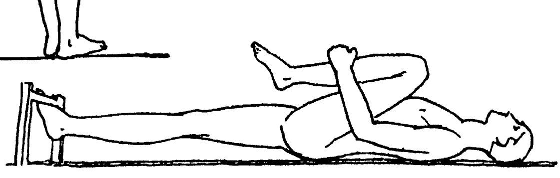
Exercise 1. Stand with the head up, chin drawn in, chest well forward and abdomen in. Hands to the sides. Then raise the arms forwards with the palms down; stretch them up, at the same time rising on tiptoe and inhaling. Stretch the arms sideways and lower them, palms turned to the back; lower the body to the heels, and exhale. Repeat the exercise twenty times.

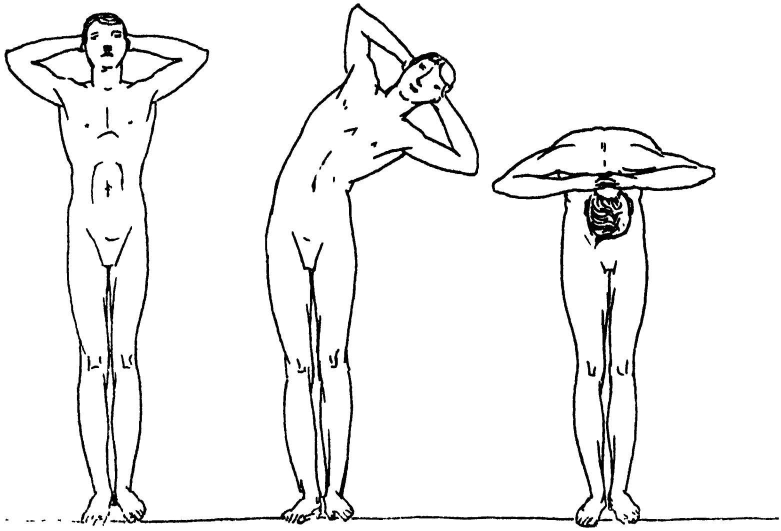
Exercise 2. Stand with head and body as before; the arms behind the back, the hands resting on the small of the back, with their fingers interlocked, palms out. Straighten the arms, at the same time turning the palms in whilst keeping the fingers interlocked. Swing the straightened arms downwards and then up and out from the body, hands still locked. Then twist the arms and shoulders round, and bend the head back. Keep in this position for a moment, then slowly reverse all the movements. If at first the fingers tend to come unlocked, use a loop of cord instead of interlacing them, until the other method becomes practicable. Repeat twenty times.

Exercise 3. Lie on the back with the hands on the hips; then raise the legs alternately, bending the knee so that it touches the abdomen. With the hands then clasp the knee and press it on to the abdomen as firmly as possible for a few moments. Repeat this twenty times, with the legs alternating.









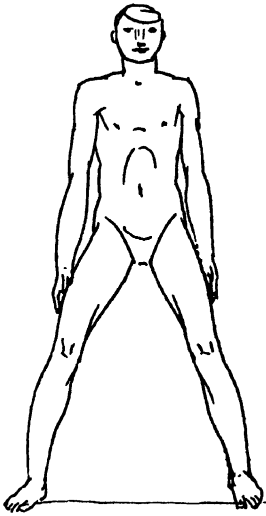
Exercise 4. Stand as in the first exercise, but with the arms extended sideways, and the hands clasped behind the head. Keeping the arms and head in their relative positions, bend sideways from the waist, first right, then forwards, then left, and then back, returning to the first position; so that the head describes a circle. The knees should be straight, and the feet together. Repeat this exercise in sets of five times each way, twenty times in all.

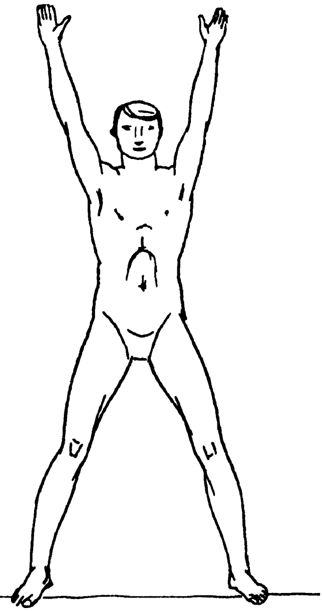
Exercise 5. Stand as in the last exercise. Bend the head and elbows back as far as possible, strongly; then bring the elbows forward, relaxing the muscles. Repeat twenty times.

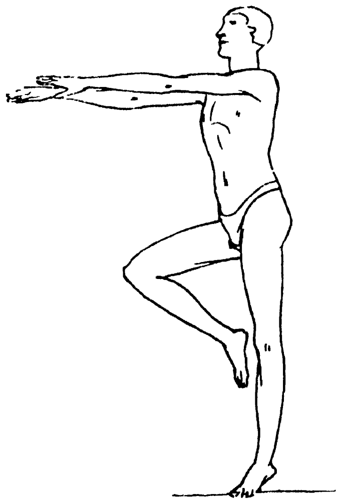
Exercise 6. Stand with the arms at the sides, but the feet from twenty-five to thirty inches apart. Stretch the arms sideways till they are above the head, then bend forward till both hands touch the floor. Slowly rise, and bring the arms to the sides. Repeat this twenty times.

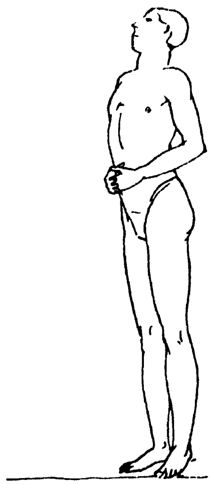
Exercise 7. Stand with the arms stretched forward; then swing them out at the same level sideways, then up above the head; at the same time moving the legs as if running, but keeping on one spot. The steps should be at the rate of about three to the second, and the arms should be held in each position for fifty steps.

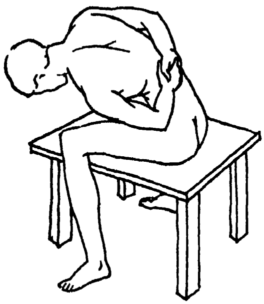
Exercise 8. Stand with the hands firmly clasped on the abdomen, and breathe in, at the same time strongly pressing in the abdomen; then breathe out, and allow the muscles to slacken.



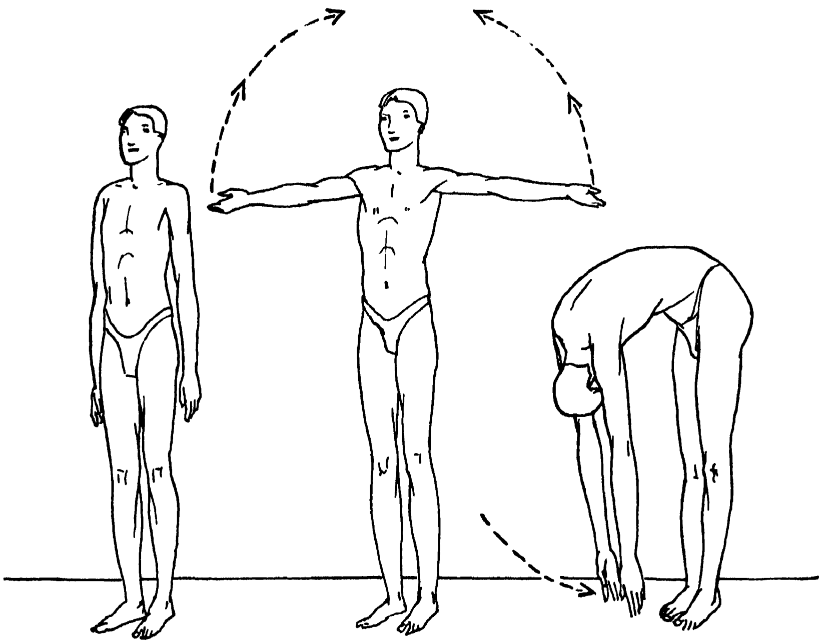








Exercise 9. Sit on a stool with the hands clasped behind the back. Then bend strongly forward from the waist, then to the right, backward, to the left, and so up to the starting position, so that the body describes a circle. Repeat this twenty times.



Exercise 10. Stand with the arms to the sides; then raise them sideways till they are stretched above the head, while breathing in. Bend the body forward with the arms still in a line with the trunk, till the hands touch the floor; rise again, and lower the arms to the sides, while breathing out. Repeat this twenty times.

Clothing

In the matter of clothing, town-dwellers are too apt to permit the stupidity of fashion to impose real fetters upon them.

All clothing should be worn loose. Tightness anywhere interferes with muscular action and impedes and impairs the circulation of the blood. Even sock-suspenders are objectionable, and garters are even more so. Tight boots and shoes are objectionable, even more because their evil effects are not always easily recognizable. Fatigue, attributed to other causes, is often due to the undue cramping of the feet, helped by tight socks or stockings.

The part of the body to which constriction is usually most firmly and diligently applied is that which above others should be free from any semblance thereof, namely, the neck. The narrow isthmus which connects the head with the trunk contains a large number of very important structures: muscles, arteries, veins, nerves, and glands; the main air-passage, the trachea; and the main food-passage, the gullet. These are all closely packed in front of the bony spinal column. The blood-vessels and nerves here form the connecting links between the brain and the rest of the body, and are in this respect the most important organs in the body, so that their full freedom of activity should on no account be interfered with. Yet modern man so arranges his neckwear as to bind all these organs against the unyielding spinal column. The degree of compression to which some will submit whilst loudly protesting that there is no compression at all, is sometimes very astonishing, presumably because the constriction has been gradually applied. If we look at the costume of those who are really active in sports—cricketers, tennis-players, oarsmen—we see that their necks are always perfectly free; yet the people who are engaged in brain work, which is work *par excellence* requiring a good supply of blood to the brain and a free drainage therefrom, are, above all others, those who wear the highest and tightest collars. If you ask a person thus trussed and corseted about his neck to bend down as though to lace his boots, the sudden and alarming congestion with which his face becomes suffused will prevent you from repeating the experiment. The limp collars, now so often worn, are often even more dangerous than those which are starched; not only because they shrink in the wash, but because those who affect them seem to find it necessary to keep them in place by pulling the tie so tightly as to threaten strangulation. Neckwear which fails to admit one hand quite freely up to the knuckles between itself and the skin, is injuriously tight. It is well to remember that the gaseous exhalations from the skin of the chest, abdomen, and back find a natural exit at the neck. By no means the least objection to a tight collar is that it imprisons these unwholesome gases.

Care of the Hair

The health of the hair, like the health of every part of the body, depends upon a pure blood supply. If hair is to be kept in good condition it must be stimulated. In the absence of stimulation the roots become apathetic and eventually atrophy from inanition. When women still wore long hair the weight of this itself stimulated the roots, and the necessary brushing and combing reinforced the stimulus. For this reason they rarely grew bald, whereas their husbands and fathers who wore their hair short and kept it in its place by means of greasy lotions, which obviated the necessity for more than a very perfunctory brushing, grew bald early. Now that women bob their hair and shingle it, they too are likely to become bald unless they remain as attached to the hair-brush and other means of stimulation as they were when they still retained their tresses. Threatening baldness should be met not by so-called stimulating lotions, but by vigorous friction with brush, comb, and finger, and by moving the scalp on the underlying bone. All this takes time and energy and perseverance: but there is no other way, no royal road.

The pressure of the hat is sometimes cited as a cause of baldness; but, in fact, hats are seldom on the head long enough to do any real damage. The direction in which hats are calculated to do harm—male hats—is in that of harbouring dirt, and thus of causing infection of the brow and hairy scalp. Men will wear the same hat, week after week, and month after month, perspire in it, and leave it about in all manner of odd places, and never once subject it to any more cleansing process than a perfunctory superficial external brushing. A hat which is worn constantly should be kept clean. The inside leather band should be turned outwards and washed with soap and water at least once a week. Except the hands, the skin of the brow is probably the dirtiest part of the body, and yet very little attention is usually paid to its artificial covering. Even vests are occasionally sent to the wash!

Care of the Eyes

Originally used chiefly for long distance, the advance of civilization has determined that the activities of our eyes should be almost entirely restricted to middle distance and near vision. This supplies the reason for the comparative rarity of perfectly normal vision among town-dwelling children of the educated classes. The structural development of the eye demands that it should, so to speak, be 'brought up' on long-distance vision, just as the adequate development of the bony framework demands that it should be 'brought up' on vigorous muscular exercise and fresh air. The practice of teaching children from

blackboards is better than teaching them from books, but neither is entirely justifiable unless it is freely diluted with practice in long-distance vision. The eye is an optical instrument, and stands alone among the organs of the body in the fact that its adequacy for the task which it is intended to perform can be measured with mathematical precision. The large and ever-increasing number of people who are obliged to wear glasses constantly, testifies not only to the increasing knowledge and skill of oculists, but also, and more emphatically, to the fact that too little attention is paid to the developmental exercise of the eyes in childhood. From the moment it begins to be used as an organ of observation, the present-day eye is given too much near work and too little distance work, with the result that it develops, structurally, along faulty lines, and when fully matured requires glasses to correct its faults.

Where the eyes are concerned it is a fact that minor errors are often more serious in their results than gross errors. Gross errors are easily detected and corrected, whereas slight errors are not. If a child cannot see the figures on the blackboard his inability soon becomes apparent; but if his next-door neighbour is able to see them at all it generally goes unsuspected that he may be seeing them with difficulty. The latter goes on seeing them, and adjusts his ocular apparatus so as to obtain perfectly clear definition, and this adjustment soon becomes habitual with him. This means that energy which properly belongs elsewhere is being illegitimately attracted to the visual organ, so that although the child sees well, he does so at a physiological cost which it becomes increasingly difficult for him to pay.

The physiological price which a person may thus have to pay for uncorrected slight errors of refraction may take many forms. By far the commonest of these is headache. The headache of eye strain is worst in the morning, on waking, especially if, the night before, the eyes have been severely taxed, as in reading; or taxed in an unusual manner, as at a theatre or a cinema. A picture gallery, indeed sight-seeing generally, is very liable to give rise to the headache of eye strain. The character of the discomfort is usually a dull ache, which attacks by preference the brow, or one side of it, or the back of the head. The pain may, however, be very acute; sharp, cutting, and paroxysmal in quality. Pains of eye strain are often accompanied by an intolerance of light; and in severe cases by vomiting. Many so-called 'bilious attacks' are ocular in origin.

Having regard to the amount of the world's work which nowadays demands complete ocular efficiency, and considering the trick which slight errors have of masquerading as defects in other organs, it is a wise rule which bids parents and guardians satisfy themselves by expert advice that the eyesight of their children and wards is as it should

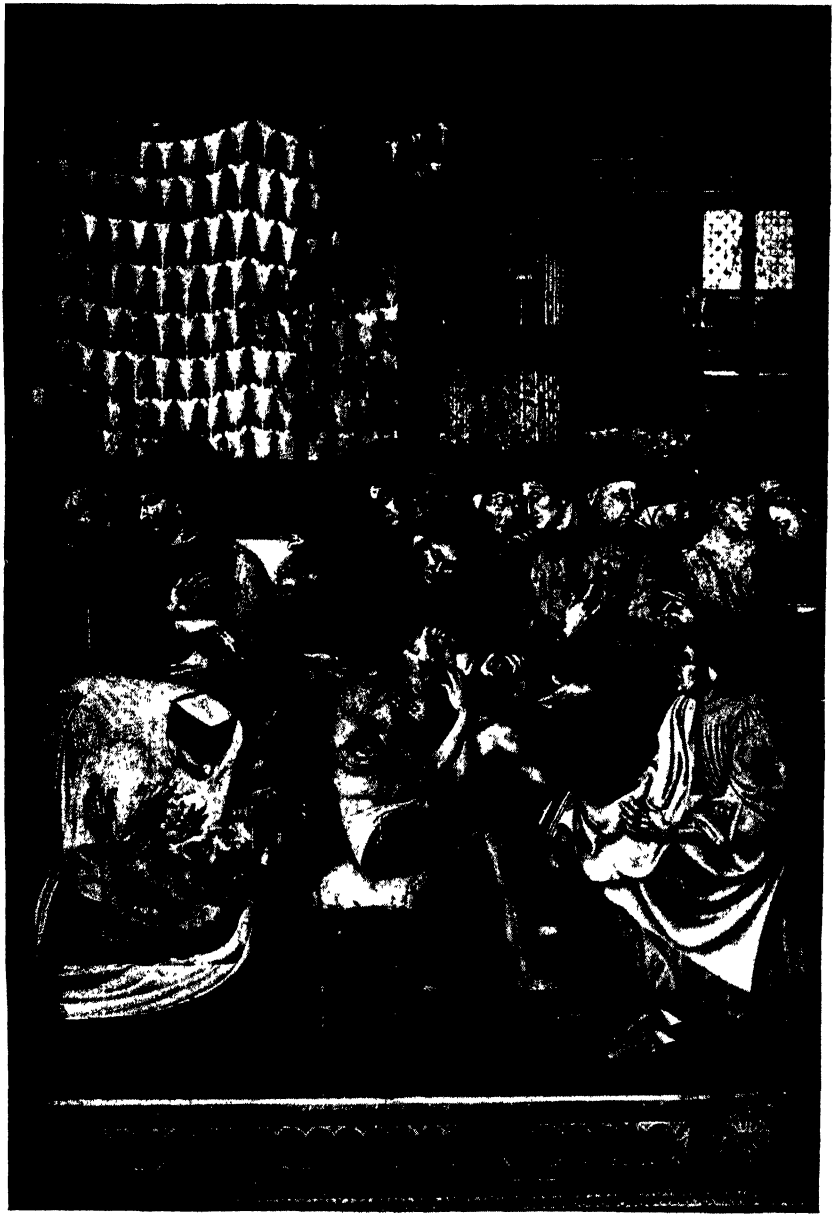
be, before these are set to serious study. Many an unexpected failure in examinations which has been attributed to idleness or lack of application has in reality been due to some slight ocular defect. A great deal of indefinable *malaise* in adults, to say nothing of seeming defects in character and even in morals, has been found on investigation to depend on the same unsuspected cause. Eye strain is undoubtedly responsible for a large measure of wretchedness in civilized life which a little forethought and understanding would easily remove. It is a by no means uncommon cause of insomnia. It is one, at any rate, of the causes of sea-sickness—some say, the principal cause. The agricultural labourer does not suffer from eye strain.

Care of the Ears

What are commonly called the features of the face—eyes, nose, mouth, and chin—are generally regarded as revealing certain mental and moral characteristics, but none of them is in reality so tell-tale as is the external ear. The lobe of the ear, for example, is peculiar to human beings, and represents a high grade of development. It is, nevertheless, completely absent in a large number of people; an absence which should thus suggest—though not prove—a low capacity. Another sign which suggests a measure of degeneration is the presence of the little elevated tubercle, which is not infrequently found near the upper part of the margin of the ear. This, according to Darwin, is the vestigial survival of the tip of the pointed ear found in most of the lower animals. Deviations from the normal human ear are also to be seen in very large ears, in ears which protrude at right angles from the head, and in those which are not involuted. These stigmata are more common in women than in men, which may explain the female fashion of covering the ears with the hair.

The external ear is an important index of health. Its colour should in no wise differ from that of the rest of the body. It is, in common with all parts of the head, not infrequently held in a state of chronic congestion by the undue constriction of the collar or the neckband, but even when such purely mechanical causes are not in question the external ear is often deep red or purple, in comparison with the rest of the surface. This is usually due to a chronic error in metabolism most commonly dependent upon constipation. Whenever it is observed it merits attention.

The ear is the organ of fear, and fear, so some say, rules the world. If a person standing on Westminster Bridge, contemplating the Victoria Tower, were to see it suddenly and noiselessly collapse, he would be surprised, but he would not be afraid. If, however, the sudden collapse were attended by a deafening noise, his surprise would be



By courtesy of Miss D. Hartley

A FIFTEENTH-CENTURY HOSPITAL WARD

From the Frescoes in the Hospital of Maria della Scala at Siena

swallowed up in terror. All animals are more easily frightened through the medium of their ears than in any other way. Man has inherited this sensitiveness, for his nervous system generally is more readily affected through his organ of hearing than through his vision or his smell. An unexpected noise, especially if it be an unfamiliar one, will cause him to start. A noise will awaken him from his deepest sleep. In the presence of unfamiliar noises he cannot rest; and the noises arising in the ears themselves, or in the aural nerves, which trouble certain sufferers from deafness are sometimes so intolerable as to drive their victims to suicide.

It is an unfortunate fact that all the material advances in civilization seem to be accompanied by an increase in noise. Setting aside the din of factories and of machinery generally, such blessings as are conferred upon us by telephones, motor cars, aeroplanes, and tube railways are seriously discounted by the great increase in noise which they entail. It is probable that we are able in some subtle unconscious manner to distinguish between necessary noises and those which are unnecessary, and that it is the latter only which 'get on our nerves,' as we say. It is certainly true that unnecessary noises are more wearing to the nervous system generally, than those which are recognized as inevitable. A continuous noise, however necessary and inevitable, is nevertheless very tiring. The fatigue, for example, of a long railway journey is undoubtedly due more to the noise than to any other cause. At least one well-known medical man puts cotton-wool in his ears as soon as he starts on a long journey, an expedient which he finds definitely to lessen the weariness. Incidentally it enables him to plead deafness to his loquacious fellow-passengers. It is therefore obvious that noise, whether or not it causes conscious irritation, has in the long run an exhausting effect upon the central nervous system. Sleep in a railway train is not a refreshing sleep.

The practical outcome of these considerations is that a certain amount of quiet is necessary to every one, every day. In its absence the nervous system fails to obtain the real repose which is essential to its ultimate well-being. If curtain lectures and other domestic amenities render this freedom difficult of attainment at home, the victim should join a club or other institution in which there is a silence-room provided with deep arm-chairs.

Sleep

Nature's method of ensuring quiet is by means of sleep. The physiology of sleep is not fully understood, but it seems evident that it is brought about by cutting off the blood-supply to the brain. It also seems clear that the mechanism by which the cutting-off is effected

includes something in the nature of a stop-cock, so suddenly does one pass from consciousness to unconsciousness.

The amount of sleep actually necessary to any particular person is an individual matter which varies within very wide limits. It may, however, be safely affirmed that just as the majority eat too much, so the majority sleep too much. Too much sleep means that the brain is insufficiently exercised, which is just as bad for the mental side of man as insufficient muscular exercise is for the bodily side. In any case an occasional relative diminution in the usual amount of sleep does no one any harm; indeed, like fasting, it may do a great deal of good. And just as the majority of people hold to very exalted standards as to the amount of food they require, so do they nourish a very special solicitude on the subject of the quantity of sleep they require. And the curious and almost ludicrous fact is that the two, excessive food and excessive sleep, are mutually exclusive. The organism knows, though the individual does not, that the best means of putting up a barrage against excessive food is to deprive the feeder of his sleep, ensuring by this means that the tissues are not overloaded with useless nutritive material. For although such a person is somnolent during the day owing to the determination of blood from his brain to his stomach, he is unable to sleep at night because a provident Nature sees danger in allowing him to do so. The person who is 'a martyr to insomnia,' in eight cases out of ten is a person who is in reality a martyr to his own gluttony. If he were to sleep, as he thinks he has a right to do, he would be undone by a rush of nutritive substances to a system already overburdened with useless material. There would be a turmoil followed by an explosion; that way apoplexy lies. For such people the best sleeping draught is an emetic.

Care of the Nose

The nose has three important functions. The one most generally associated with this prominent organ is the sense of smell, which is in reality the least important of the three. Of the other two, one has a very close connection with breathing, the other with voice production. The sense of smell in human beings is a very attenuated affair compared with that of the other higher vertebrates—except the apes, which have practically no sense of smell. Happily for him, perhaps, a town-dwelling man very rapidly loses what little perception of odours he was originally given, probably because his olfactory nerves are so over-stimulated by the smells and gases of great cities that they rapidly wear out. By the age of sixty, most men have lost all their finer olfactory perceptions.

The function of the nose which is of the greatest importance to civilized man, especially to the town dweller, is the action which it

exercises upon the inspired air. In this country the ordinary air of cities is cold and laden with particles. As this is passed through the nose on its way to the lungs it becomes filtered and warmed, so that on arrival at its destination it is free from gross impurities and is of the right temperature. It follows that every one should breathe through his nostrils and not through his mouth. In order to test an individual's efficiency in this matter it is necessary to block each nostril in turn so as to be certain that deep inspirations reveal a perfectly clear air-way on each side. Some people who breathe through their noses in ordinary quiet conditions are nevertheless obliged to open their mouths when taking exercise or during sleep. Such people have not fully patent nasal passages. The penalty, which must in the long run be paid by a town-dweller for even a partially occluded air-way, is chronic bronchitis and the other troubles of the air passages which are provoked by cold unfiltered air.

Having regard to the fact that the atmosphere of large towns is usually heavily laden, not only with tangible impurities, such as coal-dust, but with intangible poisons, microbic and chemical, it is highly desirable that the delicate and sensitive mucous membrane of the nostrils should be kept as clean as circumstances will allow. There are hundreds of people who diligently clean their teeth, who never dream of applying simple soap and water to the inside of the nose. Every one should wash the inside of his nose whenever he washes his face. If by so doing he can provoke a hearty sneeze, so much the better. Ointments applied to the inside of the nostrils are occasionally useful. Douching the nose is a very useful procedure if the fluid used is of proper consistency and temperature; but it is a procedure which requires an apprenticeship.

Care of the Mouth

The mouth is the gateway not only of the digestive organs, but also to some extent of the lungs, and to a less extent of the nasal cavity and accessory sinuses. It contains the tongue, the teeth, the tonsils, the openings of the salivary ducts, and the orifice of the Eustachian tubes, which lead into the middle ear on each side.

The idea that the state of the tongue is a true index of the state of the rest of the upper digestive tract is firmly fixed in the minds of most people. By the medical profession, however, it is now recognized that a furred tongue is more often due to local causes than to general, and that a so-called clean tongue may be merely the result of the fur having been rubbed off by a meal demanding plenty of mastication. Invalids and people who live on sloppy food often have dirty tongues. A pale,

flabby, tooth-indented tongue, on the other hand, does usually mean debility, and is consequently a matter demanding attention.

There is nowadays very little danger of decayed or defective teeth escaping the notice of a competent dentist, and since this matter has been accorded its proper importance in schools and elsewhere, the health of the public has notably improved. Pyorrhoea, an inflammatory state of the gums, is sometimes due to a spread of infection from the teeth themselves, but more often it is a manifestation of a constitutionally unsatisfactory state of the blood, due often to constipation. Local measures against pyorrhoea are useful enough in their way, but they cannot be wholly successful unless the underlying constitutional cause, which is nearly always dietetic, is properly treated.

The tonsils, which are sentinels whose duty is to defend the air passages against infection, are in town-dwellers kept very busy. They not infrequently succumb under the burden, and become so impregnated with toxins that, instead of being defenders, they act as store-houses and distributors of the poisons they are meant to nullify. They should then be removed. In mouth-breathers the tonsils endeavour to play the part normally played by the nostrils, that, namely, of warming and filtering the incoming air, but as they are not intended for this employment they enlarge and obstruct the passages. It is wise to help enlarged tonsils in their defensive work in foggy and dusty weather by frequent gargling.

Quite close to the tonsil on each side is the small orifice of the Eustachian tube. As this tube leads to the closed cavity of the middle ear, infection of which is likely to be a very serious matter, it is well to promote cleanliness of the back of the throat by simple means, such as gargling at least twice daily, night and morning, with soap and water, sea-water, or some other mild antiseptic. A little reflection will show that, important as cleanliness is in all parts of the body, there is no part where it is more essential than it is in the mouth. The teeth are usually subjected to fairly vigorous brushing, which is no doubt all to the good, but it is to be remembered that in proportion as people eat normal natural foods and masticate them thoroughly, the importance of the tooth-brush wanes. The unsophisticated savage, who lives on natural uncooked foods and never sees a tooth-brush, has beautiful teeth. Nor would gargling and washing out the mouth with soap and water and other cleansing fluids be as necessary as they now are if less sticky, starchy, and saccharine food were consumed. The saliva is itself very antiseptic and cleansing, but ordinary quantities of it are insufficient to cope with the tasks set for it by the quantities of artificial and concentrated foods which are swallowed by most people.

There are three pairs of salivary glands in the mouth; one pair, the parotids, supplies the upper jaw, the other two, the sub-maxillary and

sub-lingual, supply the lower, on each side. The amount of saliva which is poured into the mouth by these glands may amount to several pints in the twenty-four hours. It is always being secreted, night and day, but there is of course a special flush as soon as food is placed in the mouth. It is instructive to note that certain substances increase the flow of this beneficent fluid, whilst others depress it. Among the most powerful depressants are bread and butter, tea, tannic acid, and meat. The most powerful stimulators of the salivary secretion are vegetable acid foods, such as fruits and salads. The proper care of the teeth thus resolves itself into a question of a suitable dietary, and, as one would expect, the fact which emerges most prominently is that the substances which are most suitable to the preservation of the teeth are the natural foods which have undergone the least artificial preparation, and have therefore retained their vitamins; the foods in fact which are most suitable to the preservation of the general health.

XI—OCCUPATIONAL PROBLEMS

DISEASES and disorders of body or mind due more or less directly to the occupation of the sufferers offer a wide scope for preventive medicine. Already a very great deal has been done by legislation—in which Great Britain has largely led the way—to promote satisfactory conditions in our factories and workshops, but there is still a great deal left undone, especially along the lines of vocational guidance and accident prevention, where psychological factors have to be considered.

Occupational diseases are brought about by a mixed set of circumstances in many instances. Where a person is working day after day exclusively with some poisonous metal, the effect upon his health may be obvious and direct, and easy to prevent. In other cases the effect of an occupation may be indirect, and not obvious enough to prevent harm being done. The subject can be considered under three main headings:

(*a*) Premises and conditions of work, including the machinery used and the mode of working.
(*b*) Materials used.
(*c*) Suitability of the worker for the work.

PREMISES AND CONDITIONS OF WORK

It is obvious that such fundamental conditions as sanitation, heating, and lighting, ventilation, air space, etc., will play just as important a part in the workshop as in the home, and problems common to all situations need not be here again discussed. The general conditions of work may be dangerous without being unhealthy. Certain risks of work in any occupation may be the risks also of everyday life, such as electric shock (naturally more likely to happen where high tension is used), motor car accidents, to say nothing of the 'earthquakes, riots, and civil commotion' mentioned in every insurance policy.

LIGHTING.

Lighting is of great importance, as eye strain may soon develop where the conditions do not permit of adequate illumination. Among coal miners, who work in a cramped position with poor light for long periods of time, a curious oscillatory movement of the eyes called 'nystagmus' sometimes develops, but nowadays it is thought that psychological

causes may be in part responsible for this. Where great demands are made upon the eye, as in factories where electric bulbs are tested, or where the work is done at sewing machines, a similar condition is said to develop.

HEATING AND VENTILATION.

Heating and ventilation are closely associated. Firemen, steel and iron workers, and others, carrying out their duties at excessively *high temperatures*, may suffer from severe disturbance of the heat-regulating mechanism of the body, especially if the atmosphere is so humid that adequate loss of heat by perspiration is prevented. Heat stroke, severe collapse, and prostration occur, with sometimes severe degrees of 'cramp' and heart weakness. In connection with the weaving of cottons and other textiles it is thought to be essential to have the atmosphere warm and moist. Workers in such conditions may suffer from severe discomfort if the temperature is high, and it is also held that such people are liable to suffer from bronchitis. Another serious effect of heat is that the lens of the eye may become diseased. The constant hot glare of a furnace, in a glass-blowing factory, for example, may lead to the development of cataract, with eventual blindness. A recent occupational disease associated with heat is that found among cinematograph operators who work in a closely confined space, often badly ventilated and full of machinery. The noise of the projectors is said to produce various nervous disturbances, while the unpleasant fumes given off from the electric arc (especially the copper element of the arc) may be contributory to the state of the bodily and mental collapse which sometimes develops.

Low temperature may also be responsible for danger to health. Nowadays there are a great number of people employed in refrigerator store-rooms where frozen meat, etc., is kept, and there are also workers in ice stores and ice factories. Various disorders of the rheumatic type are found to occur among such individuals—including lumbago and neuralgia, while bronchitis and diarrhoea are also not uncommon. Frost-bite has also been recorded in such workers. Much has been done in the modern refrigerator store to protect the workpeople, by insistence upon proper clothing, clogs for the feet, and attention to the floors to prevent dampness. The risk of being shut inside a cold-storage room has been reduced by the provision of bells.

To a less extent many outdoor workers run similar risks as regards low temperature and dampness, but few of the disorders likely to occur are specifically attached to any particular form of work. It is notorious in London, for example, that policemen are specially liable to pneumonia, but whether this is due to the out-of-door work, the type of clothing, or the conditions of the station-life, is not clear. Nor can dampness alone

be blamed for the articular rheumatism from which gardeners and others suffer, since the rheumatic group of disorders was remarkably absent from the men living under terrible conditions of dampness in the European War.

ATMOSPHERIC PRESSURE.

Atmospheric pressure plays an important part in some diseases. Reduced pressures, such as are met with at high altitudes, are responsible for a whole train of symptoms known as 'mountain sickness,' but this can scarcely be regarded as an occupational disorder except possibly among the employees of the air-transport companies. Increased atmospheric pressure, on the other hand, is responsible for a very interesting and important disorder usually called 'caisson disease.' The effects were first discovered and studied in persons working in caissons or diving bells where compressed air is necessary to make work possible under the level of the sea, for example. Sometimes the effects are produced while the pressure is being applied, but more commonly while it is being reduced. The chief symptoms are headache, giddiness, and pain in the ears, with sometimes rupture of the ear drums. In serious cases, vomiting, severe shortness of breath, great pains in the muscles and joints, and nose-bleeding may occur; while loss of consciousness, paralysis, or even death from internal haemorrhage, has at times resulted. These various disorders appear to be due to the fact that under the increased pressure much more gas than usual (from the atmosphere) is dissolved in the blood, and when decompression occurs too quickly this gas comes off in bubbles, at too quick a rate to be got rid of through the lungs, with the results already mentioned. A system of slow decompression in special chambers has been very satisfactory in preventing caisson disease, and there are also nowadays regulations as to the speed at which divers should be allowed to come to the surface.

LOCAL DISORDERS.

Certain types of work may produce local disease in the body. Thus, if the machinery used or the position at work causes any friction on any part of the body, blisters and later 'corns' may develop, and there are many picturesque names associated with such troubles: 'Weaver's bottom'—'Deal-runner's shoulder'—'Miner's elbow'—'Housemaid's knee.' In much the same category may be placed 'Clergyman's sore throat,' which is by no means confined to the clerical profession, being, indeed, prevalent among schoolmasters (where blackboard chalk is a contributory cause), and among bookmakers, where alcoholism may help to set up the chronic inflammation of the larynx, which is the real seat of the trouble. Flat-foot, from which so many nurses suffer, is

thought to be due to the prolonged standing which is considered necessary during their period of training, often combined in the young probationer with ill-fitting shoes. A more humane treatment of the young nurse would do a lot to prevent this.

X-ray dermatitis (inflammation of the skin) has been one of the tragic results of the discovery of this most valuable means of investigation and treatment of disease, and the early workers with X-rays and radium suffered from this malady, which is liable to become cancerous. There have been martyrs in every centre where these radiations have been used, but nowadays adequate protection by means of metal sheets, etc., is being carried out and it is hoped that such disasters will in future be rare. The occurrence of a series of deaths in America among workers who *some time before* had been using radium paint indicates the serious risks attached to this powerful substance.

NOISE.

The noise of modern machinery may produce disorders of hearing which are of importance. What is known as 'boiler-maker's deafness' is apparently due to a slow destruction of the fine nervous mechanism in the innermost parts of the ear. It occurs among those concerned in hammering metal sheets, driving engines, working pneumatic drills, etc., and it is thought that the use of ear-plugs will prevent the disorder.

ACCIDENTS.

Mechanical accidents are among the occupational risks of the modern worker, and accident prevention has received much attention in recent years. There are two elements concerned—the machine and the persons involved in the accidents. As regards the machines, regulations are very strict as to the protection which must be incorporated in the actual construction of the apparatus, and it is probable that there are very few machines where the best possible safety device is not already in use. In other words, not much more can be done in the way of protection from the mechanical aspect. The personal factor is of great importance. Investigations have already shown the effects of fatigue, speed of work, age of the workers, eyesight, etc., upon the occurrence of accidents. More detailed studies suggest that certain people are more prone to be involved in accidents than others. In other words, people may be susceptible to accidents as they are to certain diseases. Poor co-ordination of the muscles, and temperamental instability, appear to be the faults most likely to lead to accidents, and to a certain extent these conditions can be detected *before* accidents have occurred. There may be more logic than appears at first sight in the alleged French practice of arresting any pedestrian who is knocked

down by a motor car! The psychological problems involved in this aspect of occupational disorders will be mentioned later under the question of the suitability of worker for the work.

Disorders due to Material Used

This group of occupational disorders comprises cases of industrial poisoning where poisonous material gets into the system through the food-canal, the lungs, or the skin. A brief account of the principal varieties will now be given.

Poisoning because of absorption through the food-canal may be caused by lead, arsenic, phosphorus, mercury, zinc, antimony, etc. In certain occupations it is held that inhalation of fumes through the lungs is of more importance.

LEAD POISONING.

This is one of the most important forms of industrial poisoning because it is so widespread and because preventive measures hold out great hopes for its eradication. In the manufacture of lead the smelters are prone to be attacked, and it is also common among those workers who turn the metal into the finished article—makers of sheet lead, lead piping, bullets, etc. In the printing trade there is a risk of poisoning by lead among the compositors and other workers. Painters are very liable to lead poisoning on account of the white lead used in their work. In the tinning of iron and the glazing of pottery and in certain parts of the manufacture of glassware, risks of lead poisoning are present. It is thought, nowadays, that a great deal of the metal enters the body by the inhalation of fumes or dust. Women are specially liable to be affected. The principle manifestations of lead poisoning include a blue line on the gums (in the presence of bad teeth), severe abdominal pain (colic), and involvement of the nervous system causing paralysis, especially of the arm-muscles (wrist-drop), and, later, serious disease of the brain with convulsions. Kidney disease may also develop. The preventive measures suggested, and often insisted upon by legislation, in connection with lead poisoning are multifarious. In many instances other less dangerous metals could be used as substitutes, and this particularly applies to the glaze used in pottery and to white paint. Attention to dust and fumes is insisted upon in certain trades, and respirators to fit over the nose and mouth have been recommended. Personal cleanliness is very important, so that the metal shall not accumulate on the skin. Special drinks have been advised, such as one containing magnesium sulphate, or milk, or weak sulphuric acid. In certain industries where the risk of lead poisoning is great, the employment of women is forbidden.

ARSENICAL POISONING.

Arsenic is used in the manufacture of certain paints (e.g. emerald green), in sheep-dip and weed-killer, and in 'shot.' In certain forms of pottery- and glass-making, arsenic may come into the process. Workers in these trades may become affected. The fumes of the deadly 'arseniuretted hydrogen' occur in certain chemical works, and those dealing with skins and furs may suffer from this gas. Fortunately arsenical poisoning in industry has become rare in recent years following strict attention to preventive measures. The metal acts as an irritant in the body, producing severe irritative inflammation of the eyes, nose, and skin with ulceration and pigmentation (increase in dark colour of the skin). Sometimes severe vomiting and diarrhoea occur, while poisoning of the liver, kidneys, and nervous system may happen in severe cases. Prevention is along the same lines as already outlined for lead poisoning. It has proved very effective, especially as regards the manufacture of paint.

PHOSPHORUS POISONING.

In the old days, when matches were made out of yellow phosphorus, poisoning was comparatively common, but since 1910 legislation has attempted to prohibit this variety of phosphorus in match-making with extremely successful results. Phosphorus poisoning may also occur where a special metallic alloy called 'phosphor bronze' is cast. As regards the match industry, the trouble used to come from the fumes given off during the mixing of the material necessary for the non-safety type of match-head. Short of prohibiting the use of yellow phosphorus, these fumes cannot be prevented. A chemical substitute for yellow phosphorus is now used for this type of match, and for the safety-match the non-poisonous red phosphorus is employed. The principal trouble in phosphorus poisoning is a terrible slow destruction of the bones of the jaw, especially if bad teeth are present. This is seldom seen nowadays. The liver is sometimes involved in phosphorus poisoning, while skin troubles and inflammation of the nerves may sometimes occur. Prevention has largely been effected by prohibition. If yellow phosphorus must be used every possible precaution should be taken to deal with the fumes by adequate ventilation.

MERCURIAL POISONING.

Mercury is used in certain industries, as in the manufacture of barometers, thermometers, electrical meters, and 'ultra-violet' lamps (mercury-vapour type). Chemists dealing with compounds of mercury, photographers, taxidermists, gun-makers, and workers in explosive factories may be poisoned by this metal, which enters into the materials they use. A metallic taste in the mouth is one of the first symptoms,

then the gums become very soft and spongy and muscular cramps and tremors occur; diarrhoea, neuritis, and skin troubles may all result. Preventive measures are similar to those advocated for lead. The fumes are heavy in the case of mercury, and ventilators should be near the floor level.

ZINC POISONING.

The workers in crude zinc or in brass or paint or glass manufacture are all liable to poisoning by this metal. 'Galvanizing' and 'tinning' also necessitates the use of zinc. The symptoms include a cough and shortness of breath, indicating that the respiratory system has been an important route of entry. Dizziness, headache, sweating, vomiting, and muscular cramps may occur. In a special disorder known as 'brass-founder's ague' a liability to acute shivering attacks in the middle of the night is present. Preventive measures are as for lead

ANTIMONY POISONING.

Brass workers, ore smelters, printers, and workers with enamel are liable to poisoning from antimony. Skin trouble and acute abdominal pain are the chief symptoms. Preventive measures are as for lead poisoning.

Dust Diseases

The importance of dust as a cause of occupational disorders has already been mentioned, and in certain of the types of metallic poisons described above it is thought that dust is the way in which fine metallic particles get into the body. Another way in which dust may harm the body is by producing local trouble in the lung. This accounts for a group of disorders known collectively as 'pneumoconiosis.'

In general terms dust produces its local irritative effects upon the lungs, the more markedly the more it differs in chemical composition from that of the human body. Thus, animal dusts, so long as they are free from microbes, produce little permanent damage, unless a state of hypersusceptibility exists, when asthma may occur. Vegetable dusts, as a rule, do not produce much permanent damage, although workers in cotton, felt, and 'shoddy' occasionally suffer from chronic fibrosis of the lungs known as *byssinosis*—much less common now than before preventive measures were instituted. Mineral dusts are the main offenders, and the degree of damage appears to depend largely upon the presence of free silica in the dust. (In recent times an attempt has been made to blame a compound known as 'sericite' rather than free silica itself, but the matter is by no means settled, nor does it affect the main arguments for measures of control and prevention.)

The principal occupations thought to be specially responsible for lung disorders are mining, quarrying, and those connected with the china and earthenware trades. Lung diseases also are thought to be specially common among cement workers, salt workers, steel-grinders, and, in recent years, workers in asbestos. Among miners there are numerous varieties of disease according to the mineral and type of mine. Coal miners suffer from a condition called *anthracosis* in which chronic bronchitis and some slowly progressive fibrous change in the lungs occur. Shortness of breath develops eventually and sputum is coughed up which is actually black from the coal dust present. The disease takes many years to evolve and is not associated, traditionally, with a particular susceptibility to pulmonary tuberculosis, present in some of the other forms of lung troubles to be described below. (A recent investigation among old retired miners in South Wales has thrown considerable doubt upon this immunity, as certain of them were found to have a quiet, almost hidden, type of tuberculosis in the lungs.)

In dry and dusty mines where other minerals are being obtained the disorder which most commonly occurs is known as *silicosis* because it is held to be due largely to the free silica present in the dust. In dry rock-drilling a very high percentage of workers become afflicted; while the disorder is also common among Cornish tin-miners and South African gold-miners. The manifestations appear sometimes after many years, sometimes more rapidly, and consist of extreme shortness of breath, cough, and 'gritty' sputum. There is a grave risk of tuberculosis developing in the lung, possibly because the delicate (and therefore protective) lining membrane of the interior of the fine bronchial tubes and air-spaces has been damaged by the constant irritation of dust particles. *Asbestosis* is a special type of lung disease which has come in for study in recent years. Workers in asbestos factories, after being 'exposed' for at least five years to the dust, develop a cough, great shortness of breath, wasting and loss of weight, and general weakness. Pulmonary tuberculosis is also prone to occur. *Siderosis* is the name given to the same sort of disease, with similar symptoms, which occurs among those engaged in grinding steel. It is sometimes known as 'grinder's rot.'

Prevention of all these dust diseases means keeping the dust under control. In mining, modern methods attempt to keep the dust down by the use of liquid sprays, so that the work is done under moist conditions—rock-drilling is carried out wet rather than dry. In the cotton trade wet methods are also important. In factories, ventilators are usually arranged in close communication with the actual seat of origin of the dust. For example, an exhaust ventilator can be fixed right over a grinding wheel and the metallic particles drawn straight away from the worker. In other trades, work is carried out over

gratings through which there is a forced down-draught. Where such measures are not possible, various forms of respirator-masks may be worn—although it is not always easy to persuade workmen to wear such protective devices. Attention to personal cleanliness is also important, since the dust can lurk in the clothes, in the hair, under the nails, etc., and get into the system even while the worker is away from his risky occupation.

It was mentioned above that animal dust seldom causes harm unless microbes are present. There is one very important and serious occupational disorder, known as *anthrax*, of which infected animal dust is the cause. This is primarily a disease of animals, especially of sheep and cattle, and occurs all over the world. In the human subject it is almost confined to workers in hides, hair, and foreign wool. It occurs, though rarely, in butchers, and from time to time infection from a shaving brush is reported. The commonest type of trouble is what is known as a 'malignant pustule'—a sore occurring on the face, back of neck, or arms, among men who have carried hides on the back and rubbed some of the infecting microbes into the skin. Unless treatment is promptly carried out, blood-poisoning commonly occurs, frequently with fatal results. A rarer variety occurs when the anthrax microbe gets into the lungs and produces what is known as 'wool-sorter's disease,' a sort of pneumonia generally fatal in less than a week. Preventive measures include the control of the spread of the disease among animals (precautions as to burying diseased animals, etc.), disinfecting any diseased portion of hides and skins, the use of extraction pans, overalls, and respirators by workmen, and scrupulous attention to personal cleanliness. The presence of any cuts or abrasions on the skin should mean absolute prohibition of contact with hides, skins, etc., and early reporting of any suspicious symptoms is important in view of the value of early treatment. The discovery of a special anti-serum to the poison of anthrax has made a great deal of difference to the outlook in the local skin types of the disease.

Poisonous Fumes and Gases

Poisonous fumes and gases may be responsible for another group of occupational disorders where the portal of entry is the respiratory system. *Carbon monoxide* poisoning is probably the most important of these, because it is so frequently fatal and also because the gas has no smell and early symptoms do not occur. It is found among workers in places where the fumes of burning coke escape, as from coke-ovens and lime-kilns. It is generally present in ordinary coal-gas. The gas gets quickly into the blood and prevents the proper carrying of oxygen to the tissues. Carbon monoxide poisoning is due to carelessness.

Carbon dioxide poisoning may occur among workers in chemical factories or in breweries, or where aerated waters are made. Measures are taken in these trades to prevent the danger; and usually feelings of suffocation occur early enough to enable affected persons to get into the fresh air.

Chlorine and hydrochloric acid fumes may cause trouble among workers in chemical factories, especially where chloride of lime is used to make bleaching powder. The fumes irritate the eyes and throat and may also affect the skin and produce chronic ulceration.

Ammonia and nitrous fumes may produce severe irritation of the lining of the bronchial tubes. The former are given off in a number of trade processes; and the latter in connection, more especially, with the manufacture of explosives.

Sulphuretted hydrogen is highly poisonous. Workers in tar distilleries and in gas works may become affected. In small concentrations the gas produces severe irritation of the eyes, nose, and throat, but even as little as one part per thousand may produce loss of consciousness.

Carbon disulphide is used in vulcanizing in indiarubber works and may produce very serious symptoms. At first headaches, mental dullness, feebleness of muscles, and anaemia may occur, but later severe poisoning to the whole system may set in. In view of this risk there are certain rules laid down for the use of this substance, such as adequate covering of the troughs in which it is used and proper exhaust ventilators. Periodical medical inspection of the workers is also necessary.

Symptoms similar to those caused by carbon disulphide may also result from other vapours from compounds of carbon. Various types of alcohol used in varnishes, and *benzene* used in cleaning, may give rise to headaches, sickness, and giddiness. '*Dope*' *poisoning* occurs among persons using quick-drying varnish (as in painting aeroplane wings), and is due to a carbon compound. Other compounds of carbon, such as the nitrogenous derivations of benzene, cause serious trouble. These are used mostly in connection with explosives, although in aniline dyes the same chemicals may be present. '*T. N. T.*' *poisoning* produces at first the symptoms already generalized for this group; but if the dose is continued there may be serious effects upon the blood, altering the whole chemistry of the oxygen-carrying part, and later upon the liver, which is actually destroyed, so that fatal forms of jaundice may occur. Even if recovery takes place permanent damage may have been done. We are still seeing the results of liver damage caused in this way in young munition workers during the European War (1914–18). Prevention of these disorders lies in careful medical supervision, the use of overalls, head covering, and rubber gloves, with short hours of work and adequate ventilation of the workshops.

Affections of the Skin

Affections of the skin may occur in many trades and, of materials used in various processes already described, there are many which may irritate the skin equally with the lining of the lungs. Anything which irritates the skin of the hands, for example, may produce some degree of inflammation. Thus dermatitis is found among *engineers* and others whose work involves touching oily machines, among workers in *turpentine*, among workers in *salt* (herring curers) and *shale-workers*, and even among workers in what appear to be non-irritant materials, such as those which produce the well-known 'baker's itch' or 'grocer's itch.' Laundrywomen may also suffer from dermatitis, and the hands of many a hard-working housewife are a tribute to the trying nature of her daily occupation. Individual susceptibility may very well play a part in some of these disorders.

Ulceration of the skin caused by *pitch* and by certain forms of *tar* is of importance because of the tendency of such changes in the skin to become cancerous. Adequate provision of washing accommodation (baths and lavatories) is important in prevention; so is the getting rid of as much dust as possible. *Chrome ulcers,* which occur in the skin of the workers in certain chemicals, take a long time to heal. 'Chimney-sweep's cancer' is thought to be brought about by the 'tar' present in the soot of the ordinary coal fire; it occurs after some years of exposure. The prevention of all these skin affections is largely a question of scrupulous personal hygiene and either the substitution of harmless for harmful chemicals or the addition of substances to render harmful chemicals less troublesome. Formaldehyde, for example, is said to lessen the tendency of 'pitch' to produce ulceration.

Suitability of the Worker for the Work

The psychological aspects of industry and occupational disorders have received increasing attention in recent years. While physical disabilities have always provided obvious reasons why certain work could not be done by certain people, psychological disabilities have never been so obvious, because their effects have not been closely studied until recent times. The good employer has always known that contented workpeople mean better work, but modern investigators go deeper than this. It has already been suggested that 'accident-proneness,' for example, may be present in certain individuals who are not suitable for the work in hand.

Perhaps the best-studied example of an occupational disorder due to psychological trouble and the unsuitability of the worker (at the moment) for the work in hand is to be seen in 'telegraphist's cramp.'

For many years this was regarded as some obscure disease of the nervous system. Then, just before the War, 'temperamental' factors were coming to be recognized. More recent investigations have shown that constitutional sufferers from cramp are more susceptible to muscular fatigue, have less control over the muscles employed in telegraphy, and are worse at performing tasks of quick accurate movements than are telegraphists without this susceptibility. Furthermore, the individuals with cramp presented a picture of severe psychological disturbance, conveyed by the terms 'nervous' and 'highly strung.' Workers in other occupations with the same type of disturbance may also 'break down' at their work, but it is not so strikingly obvious as in the very special and exacting work of a telegraphist. It follows that persons with this temperament should not go in for telegraphist's work. Some form of selection along pyschological lines will perhaps abolish this disorder in the future. Writer's cramp may occasionally fall into the same category.

As regards miner's nystagmus it is now suggested that it has its origin in an 'anxiety state' and is analogous to the condition recognized during the European War as 'shell shock.' The arduous nature of the work, the element of danger, and the fear of incapacity are constantly present and induce a mental state which exhibits itself in a bodily disorder which in turn spells rescue from the frightening conditions and brings the chance of adequate compensation. A proper recognition of the mental state (made worse by 'troubles' at home, strikes, wage-disputes, etc.) and a policy which aims at a gradual restoration to full work underground are urged as the method of the future to eradicate this disorder.

These are a few specific (because easily studied) occupational disorders with a psychological basis and dependent in part upon the unsuitability of the work for the worker under existing circumstances. Other forms of 'break-down' occur which are more subtle in their origin. For example, an increased sickness rate in an office (manifesting itself by such vague disorders as indigestion, neuralgia, etc.), or in a school, may sometimes be traced to the bullying methods of a manager or head master. The heads of firms who have called in expert help to investigate this sort of problem have sometimes been displeased with the result! Certain well-balanced individuals can stand up to these varieties of mental injury; but others, less well adjusted in their minds, go under. Vocational selection would help to pick out people likely to crack up under some strain and keep them out of occupations where they would be a misery to themselves and a possible danger to others.

Legislative Measures

Throughout this section stress has been laid upon the preventive aspects of the subject, for, above all disorders, those due to occupational hazards are susceptible of being dealt with by prevention. The famous 'Ordinance of Labourers,' proclaimed in 1349, was the first attempt in this country to regulate the position of master and worker. An Italian named Ramazzini is credited with being the originator of practical industrial hygiene just over three hundred years ago, but England has afforded an example to the whole world in the development of preventive measures in the factories and workshops, and what was once regarded by employers and big business men as unwarrantable interference by the Government is now accepted as a necessary part of all trade processes. Indeed, the prevention of occupational disease was found in many instances to increase the profits in the industry concerned. The principal legislative steps in the development of the present-day system can be summarized as follows:

Towards the end of the eighteenth century appeared the first instance of legislation to protect children in industry in the Chimney Sweeps Act of 1788, and in 1802 came the 'Health and Morals of Apprentices Act,' which is usually held to be the beginning of factory legislation. The early years of the nineteenth century saw the development of many more legislative measures, each advance taking place in the face of great opposition, with the usual appointment of commission after commission to postpone matters. Various acts appeared regulating the employment of children, insisting on times for meals and limiting the hours for work. In 1833 the first factory inspectors were appointed by the State, and in 1842 came the first of a series of enactments relating to work in coal mines. The celebrated 'Ten Hours Act' was passed five years later, but this, like much of the preceding legislation, only applied to young persons under eighteen years of age and to women. Various earlier acts were consolidated and important extensions made in the Factory Act of 1867, and official investigation by medical officers of the State began to bring to light ways in which health might be protected in dangerous trades. A further consolidating Act appeared eleven years later, and the whole of these various enactments were codified in the celebrated Factory and Workshops Act of 1901, the principal Act now in force. Various detailed laws referring to special trades appeared from time to time during this period of development, and by an Act passed in 1916 extensive powers for securing the welfare of factory workers were made available, and this has served to consolidate the advance in conditions of labour made during the War period. Lastly, mention must be made of the Workmen's Compensation Acts dating from 1897, whereby certain scheduled industrial diseases entitle the sufferer to monetary compensation from the employer

PART THREE

STAGES OF HUMAN LIFE

I—THE CHILD

Normal Development

THE normal development of a child can be discussed only in terms of averages, as the idea of an average is implicit in the term 'normal.' A normal child is one that borders on the average. The conception of an average is one which many mothers find difficulty in acquiring, and much unnecessary worry results from their failure. The idea may be illustrated by the perhaps more familiar batting average of a cricketer. A man's batting average is said to be thirty runs; this does not imply that he always makes thirty runs; it does not even imply that he has ever made exactly thirty runs. In one game he may make twenty-nine, in another thirty-one. He may be so fortunate as to make forty on one occasion, only to make twenty on his next appearance. So it is with the weight and height and rate of growth of children. An individual may depart considerably from the average without being considered abnormal.

WEIGHT.

The average weight of the normal infant at birth is seven pounds. Even healthy infants weighing less than five pounds require special care, especially in protecting them from heat loss. Infants over ten pounds at birth are unusual, and though their departure from the average is unlikely to affect them adversely after birth, it may give rise to difficulties during delivery. The average baby loses, in the first three days, from 6% to 9% of its body weight. A continued fall in weight after the fourth day must be considered abnormal. This loss in weight of the new-born is due to the fact that the infant excretes, in faeces and urine, more than it assimilates. It does not represent a true loss of the body tissues. After the third day the weight increases and the birth-weight is regained by the tenth day. In some normal infants the birth-weight is not regained until three weeks; but, provided that the gain from the minimum is steady, this slow gain need not be considered abnormal.

Through the first five months the infant should gain weight at the rate of five to six ounces a week. It will thus have doubled its birth-weight at the age of five months. Thereafter the increase is less, and the birth-weight is trebled at the age of one year. The smaller the birth-weight the earlier will the infant double it.

The average seven-pound baby weighs fourteen pounds at five

months and twenty-one pounds at one year. During the second year a gain of a little under seven pounds is usual. During the third year the gain is approximately four pounds. Beyond this age it is not wise to consider weight in relation to age, as the increases are too variable and are better compared with the height of the growing child.

A study of the weight of the infant and growing child is of great importance in assessing its health and progress. An infant should be weighed once a week for the first four months, once a fortnight to the age of eight months, and once every three weeks for the remainder of the first year. During the second year, weighing should be carried out once a month. More frequent weighing than this is, in the case of the normal healthy child, unnecessary, and may be misleading. In cases of illness it may be necessary and valuable.

HEIGHT.

The average length of the new-born infant is between nineteen and twenty inches. During the first year the average growth is from eight to nine inches, during the second year three and a half to four inches, and subsequently about two to three inches a year.

The height varies greatly according to racial and family peculiarities, but is not so markedly affected by disease as is the weight.

THE CIRCUMFERENCE OF THE HEAD.

This averages about thirteen and a half inches at birth, sixteen inches at six months, and seventeen and a half inches at one year. During the second year the circumference increases about one inch, and after that until the age of five years about half an inch a year. The measurement at five years is therefore twenty inches, and after this age the rate of growth diminishes to about half an inch in five years.

THE FONTANELLES.

These are the gaps between the bones of the infant's skull. The vault of the skull is made up of three pairs of bones which at birth are not united, and are to some extent movable in relation to each other. The lines of contact of these bones are called *sutures*, and these are usually filled in by the sixth month, after which movement between the bones of the skull is impossible. Where the sutures meet the fontanelles are found. The small fontanelle at the back of the skull is usually closed by the end of the second month. The larger anterior fontanelle usually measures about an inch in either direction at the end of the first year, and is closed by the age of eighteen months. Its size at birth is very variable.

Through the open anterior fontanelle the pulsations of the blood-

vessels of the brain may be felt and often seen. Such pulsation is normal. Normally the skin over the fontanelle is level with the rest of the scalp. A depressed fontanelle is associated with a debilitated condition, especially accompanying diseases which entail much loss of body fluid, as diarrhoea and vomiting. A bulging fontanelle may be a sign of grave brain disease, and is present when the pressure of the skull's contents is raised, as in hydrocephalus or 'water on the brain,' and in meningitis.

Contrary to widespread belief, there is no danger attached to washing the skin over the 'soft spot' on a baby's head. Firm rubbing with the open hand or flannel may be applied as safely to this part of the scalp as to any other; neglect of this area of the skin of the scalp is a frequent cause of a scurfy and dirty patch, which is common enough among the infants of ill-informed parents to be looked upon as normal, and known as the 'cradle cap.'

TEETH.

The temporary, deciduous, or milk teeth are twenty in number; and usually erupt in the following order:

2 lower central incisors . .	6—9 months
4 upper incisors . . .	8—12 ,,
2 lower lateral incisors . .	12—15 ,,
4 anterior molars . . .	12—15 ,,
4 canines	16—24 ,,
4 posterior molars . . .	24—30 ,,

The ages at which the teeth appear are, however, subject to wide variations. Infants are sometimes born with one or more erupted teeth; on the other hand, the non-appearance of the first tooth before the eleventh or twelfth month need not, in the absence of other signs of illness, cause anxiety.

To teething is frequently assigned a variety of minor maladies, from skin rashes and dyspepsia to convulsions and discharging ears, which may occur at this time of life. This fallacy is liable to lead to much well-intentioned neglect of a really sick child.

That teething brings nothing but teeth is certainly not true, and minor disturbances of health are frequent accompaniments of the pain and *malaise* of teething; but it is important to remember that the process of teething does not confer on an infant immunity from other causes of disease, and such possible causes should always be looked for before the trouble is assigned to teething. Teething emphasizes the inherent instability of the infantile organism, but it is certain that in the normal healthy baby it cannot produce of itself such conditions as convulsions, ear discharge, or bronchitis. If such disorders occur

they should, as at other times, be given medical attention. There is no truth in the belief that irregular eruption of the teeth, 'cutting teeth on the cross,' as it is called, is attended by special difficulty. Eruption out of the usual order may, however, be a symptom of rickets.

Medicines and devices for the alleviation of 'teething trouble' are still extensively purchased by a credulous public. The preparations of hare's brain and he-wolf's tooth which were popular for centuries have given place to no less useless teething-powders and the harmful practice of lancing the gums. These things are not helpful, and are to be condemned. A clean bone or ivory ring does no harm, and appears sometimes to afford comfort to a restless child.

Decay in the temporary teeth is probably more often due to causes operating before the birth of the child, such as faulty diet in the expectant mother, than to faulty feeding of the child after birth. The presence of caries in the temporary teeth does not imply that the second teeth will suffer a similar fate, but special attention should be paid to the diet in such cases. The problem of whether carious milk teeth should be extracted is often a difficult one, and is best left to the dentist. The regular brushing of the teeth does not produce healthy teeth, but will keep healthy teeth clean, and thereby maintain their health and their appearance. Healthy teeth are the result, in the first place, of healthy diet. Foods containing Vitamins A and D are believed to be important. The proper development of the jaws by the mastication of hard foods results in properly set teeth; malpositioned teeth are more liable to decay than evenly set teeth. The adherence of starchy or sweet foodstuffs to the teeth between meals favours dental decay, and can be obviated not only by brushing or rinsing after meals, but by finishing the meal with fruit.

VOLUNTARY MOVEMENTS: SITTING, STANDING, WALKING.

The kickings and clutchings of a new-born infant are not truly voluntary. They are known as reflex movements, and occur without the wish or control of the infant. About the fourth month voluntary purposive movement makes its appearance, and the child will grasp at objects. At about the same time the strength of the neck-muscles is sufficient to control the head when the trunk is supported. At about the seventh month the child can sit up, and can stand at the ninth or tenth month. At the age of one year the normal child will walk with support, and will become independent of support three or four months later. None of these accomplishments need to be taught to the child, and the times of their development vary very widely. Thus some children learn to walk without ever mastering the art of crawling.

Gross delay in the development of these various muscular activities may be due to physical causes, such as the child being overweight, or

weak as the result of debilitating disease. Of such diseases rickets is perhaps the most common. Delay may be due to mental retardation of all grades, from mere backwardness, which may be associated with physical debility through underfeeding or chronic ill-health, to the more serious grades of mental deficiency and idiocy. In all such cases medical advice should be sought.

When a child first walks a perfect gait must not be expected. It is not uncommon to see children of eighteen months fitted by enthusiastic shoe-salesmen with more or less expensive and usually unnecessary arch-supports and wedged heels. Some of these appliances actually do harm by resting muscles that need exercise for their proper development. In the matter of a child's gait considerable judgment is sometimes needed to distinguish between the unsteady toddling of a beginner and errors which will become permanent if not corrected early.

SPEECH.

A few simple words such as 'dada' will be correctly spoken by about the age of one year. Thereafter progress is usually rapid, and by the age of two short sentences will have been mastered. Delay in speech, as in standing and walking, may be due to general physical or mental retardation. Mental defect more commonly shows itself by delay in speech than in muscular development. In all cases of delayed speech deafness must be borne in mind as a possible cause.

Lalling or persistence of baby talk beyond the normal age is common, and is almost always the fault of the parents. It occurs, commonly, in one-child families, and is due as a rule to the desire of fond parents to prolong the babyhood of the growing child. To this end they talk only baby talk to the child and in other ways make a pet of him. The lalling child is almost invariably a spoilt child.

Stammering is a very troublesome speech defect and proves so severe a handicap in later years that in most cases expert help should be sought. It is not a defect which is easily outgrown, and special speech and breathing exercises are usually needed for its eradication. The stutterer or stammerer is usually of a nervous, sensitive disposition and acutely aware of his defect. Sympathy is therefore needed, and impatience or thoughtless comment is always harmful. At the outset of treatment attention to the general health and habits and the correction of faulty eyesight are important.

THE EXCRETIONS.

The emptying of the bowel and the bladder are reflex actions in the infant, and are brought under systematic control by the formation of a habit. The training consists in holding out the young infant over a chamber-pot from its earliest days. The hours of 'holding out' should

be regular, after feeds being usually a convenient time. In this way a regular action of the bowels can usually be obtained at a very early age, and soiled napkins become a rarity after the age of three months. Urinary continence is acquired later, but after eighteen months a child should not need a napkin during the day. Failure to acquire control at a normal age is more often the fault of those responsible for the child's training than of the child itself. In its correction punishment plays no part.

In the young infant the bowels normally act two to four times a day, but after the age of two months once or twice a day is usual. A daily evacuation is desirable but, provided the character of stools is normal and constipation (hard motions) not present, a child may miss two or three days without apparent harm. In such a case the administration of laxatives is not needed; nor is anxiety justified. If felt, it should not be communicated to the child. The daily habit should, however, be re-established by persuasion and firm handling. Local stimulation with soap-sticks and suppositories is not desirable.

The weekly 'cleansing' of the bowel widely advocated by advertisers of proprietary medicines is a pernicious but widely practised rite.

SLEEP.

During the first six to eight months of life a healthy infant will sleep almost continuously between feeds. During the later months of the first year the increasing power to control his limbs and do things will result in the child's wanting to exercise and play; and an hour should be set apart for this. A child should at all times sleep in fresh air and, if possible, in the open air; he should be shaded from the glare of direct sunlight. The rapidity with which children fall asleep after being put to bed, even in favourable surroundings, varies greatly in different individuals. Once the child has been put to bed he should be left alone and not rocked or petted or sung to. Every child should have a bed to himself. The necessity for sharing beds is the cause of much wakefulness and consequent ill-health among children of the poorer classes. Up to the age of eight children should have a minimum of twelve hours' sleep at night. They should be abed by seven o'clock.

The Feeding of the Normal Infant

The feeding of the normal infant is a subject which has only of recent years engaged the attention of the medical profession, and even in these days it is not uncommon to find members of that profession who have but the haziest ideas on this important subject. It is a part of the management of infancy which is still largely left to the mother or nurse, and it therefore behoves any one in such a position to master the simple facts in connection therewith.

The object of this section is rather to outline the easily understood principles upon which modern teaching with regard to the dieting of infants and children is founded than to set out any hidebound rules of feeding; to give a review of available methods rather than to advocate one rigid system.

THE NATURE OF THE FOOD: BREAST-FEEDING.

The consensus of informed opinion, based upon the results of innumerable observations and supported by reliable statistics, is that *normal breast-milk is the best food for the normal infant.* The change in thought on these matters has been so profound of recent years that to some the statement of such an axiom may seem superfluous—the reader may well say, 'But everybody knows that.' The fact remains that it is only in the last twenty years that this truth has been widely recognized. Moreover there are two factors at work which, unless counteracted, may well result in a widespread failure to accept this axiom. The first of these is the present economic depression which drives women who would otherwise be suckling their infants back to their offices and shops in order to help in the financial support of their homes.

The second factor which may result in a falling-off of the numbers of breast-fed infants is the understanding of better methods whereby the dangers of artificial feeding may be minimized. The death-rate among artificially-fed infants one hundred and fifty years ago was estimated at over 66%.

A knowledge of germs and their relation to disease, combined with a more securely acquired knowledge of the nutritional requirements and digestive abilities of young infants, has resulted in a great improvement in feeding methods. An infant for any reason deprived of human milk has, in these days, *almost* as good a chance of healthy survival as its more fortunate breast-fed brethren. It would, however, be a pity if such an advance in preventive medicine were made an excuse for the routine employment of what is, at best, a makeshift. Where there is normal breast-milk, a normal baby who is artificially fed is only getting second-best food. This fact with regard to breast-feeding has been stated as an axiom based on experience and universally accepted by those who know. It may, however, be of interest briefly to review certain other considerations which can lead us to the same conclusion.

ADVANTAGES OF BREAST-FEEDING.

The first of these is that in breast-milk the infant is getting a fluid adapted by Nature for his needs, containing adequate proportions of the various constituents which constitute a complete food, in an easily digestible form.

No other food, no matter how modified, cooked, diluted, or reconstructed, can exactly reproduce breast-milk.

Secondly, breast-feeding involves far less trouble than does any system of artificial feeding. This consideration will, of course, make no appeal to those who enjoy the doubtful advantage of being able to hand over to others the responsibility of managing their infants' dietary.

There is evidence that breast-milk, and especially the milk called *colostrum*, which flows from the breast in the first few days after the baby is born, contains many *anti-bodies*, that is to say, substances which have the power of killing germs, and by their presence protect the infant from infectious diseases; no such substances are found in artificial foods.

Again, the infant derives benefit from the act of sucking at the breast. The act of sucking appears to aid the natural development of the muscles used and, as a result, of the bones to which these muscles are attached. These are the bones of the jaws and palate, and on their proper development the growth of the teeth and of the air passages through the nose depends. By the use of suitable teats on bottles and a careful technique this particular disadvantage of artificial feeding may be minimized, but it is doubtful whether the exercise involved in sucking the breast can ever be accurately aped.

Finally, the mental and physical benefit which the normal mother derives from suckling her infant cannot be overlooked. The mental aspect is a question for the individual. Some mothers find what satisfaction they get inadequate recompense for the restriction of their activities which regular breast-feeding inevitably involves. Some mothers are deceived by the appearance of their milk, which, having normally a thin and more watery appearance than cow's milk, they conclude is inadequate to nourish their baby.

The physical benefits accruing to the normal mother by suckling are second only to those accruing to the infant itself. In the early weeks after the birth of the baby the act of suckling at the breast helps to promote the normal processes of shrinking, or involution, which the womb has to undergo. Not infrequently a delay in this shrinking is accompanied by low backache and blood-stained discharges, and the occurrence of such symptoms has often led to weaning the baby, when the continuance of suckling would have favoured their cure.

From the foregoing it will be clear that in the vast majority of cases breast-feeding is the ideal method of infant feeding from every point of view, and no effort should be spared by mother, nurse, or doctor to see that it is achieved. Where there is insufficient breast-milk to meet the whole needs of the infant, artificial food may have to be given in addition—complementary feeding. This, in many cases, is only a temporary measure, the supply of breast-milk later increasing

sufficiently to warrant the discontinuance of the bottle-feed. In any case what breast-milk there is should be given to the infant.

CONTRA-INDICATIONS TO BREAST-FEEDING.

Certain circumstances justify the abandonment of breast-feeding, but they are happily rare. The presence of active tuberculosis of the lungs in the mother necessitates immediate weaning. This is due to the fact that the disease is extremely infectious and the new-born baby extremely susceptible. The infection may possibly be conveyed by the milk, but is usually conveyed by contact with the mother, and the presence of this disease is an indication not only for weaning, but for complete separation of the mother and infant, if the latter's health is not to be gravely jeopardized.

Certain cases of severe heart disease necessitate artificial feeding, the slight extra strain occasioned by suckling being too much for a gravely damaged heart. This is not to say that a woman who occasionally experiences palpitation on exertion should immediately abandon breast-feeding. Many sufferers from minor degrees of heart trouble successfully nurse their babies, and indeed acquire actual benefit from the slight restriction of their usual activities which such a course entails.

Other chronic diseases, such as diabetes and kidney disease, may necessitate the abandonment of breast-feeding.

Epilepsy, if the fits have not been controlled by drugs, makes breast feeding, or indeed the care of a baby at all, unsafe. If the epileptic mother has to take large doses of such drugs as the bromides in order to prevent the fits, these drugs may be excreted in the milk in sufficient quantities to affect the infant; weaning is then the only possible course.

Local conditions of the breast itself, such as cracked nipples or breast-abscess, may necessitate a temporary interruption of feeding from the affected breast. Ordinarily they do not need complete weaning for their cure.

The return of menstruation is sometimes accompanied by an increase in the flow of milk which results in a temporary upset of the infant's digestion. This should never be a cause of weaning. There seems to be a widespread belief that at the menstrual periods the mother's milk is definitely harmful to the baby. This is not so. In most cases there is no change in the flow of milk; if the quantity is increased, the fault can easily be remedied by curtailing the feeds for a day or two at the time of the menstrual period.

The occurrence of a second pregnancy during the period of lactation is happily not as common an event in these days of birth-control as it was formerly. When it is certain that pregnancy has occurred, and not before, the baby should be slowly weaned; there is no need for a *sudden* cessation of breast-feeding.

In this connection it may be well to dispel a popular error which has had wide currency. Lactation has no ascertainable contraceptive effect. Many mothers have deluded themselves with the belief that they could not become pregnant as long as they were suckling their infant. In this belief breast-feeding has in the past been continued beyond the twelfth month, with bad effects on the infant.

A healthy woman is fulfilling a natural function in suckling her infant; if symptoms of ill-health occur during the exercise of this natural function it is not reasonable to attribute such symptoms to the act of suckling; the wise will consult their doctor with a view to finding out the true cause, which can often be easily corrected. Suckling does not of itself cause lassitude or headaches or pains or sleeplessness; therefore weaning the baby is unlikely to cure such symptoms. Some other cause should be sought.

LACTATION.

Lactation, or the pouring out of milk by the mammary gland, is sequent to the termination of pregnancy. From the early days of pregnancy changes take place in the breasts, which changes consist in a building up of the tissues of these glands to enable them to fulfil their later duties. In the final months of pregnancy it is often possible to squeeze small drops of fluid from the enlarging breasts; this fluid is not, however, milk. When pregnancy is ended with the delivery of the child certain chemical changes take place in the body, which result in an activation of the already built-up glands of the breast; the flow of milk is thus started. At first the secretion of the breasts differs somewhat from ordinary breast-milk, and is known as 'colostrum.' There is reason to suppose that this early flow from the breasts is particularly suited to the needs of the new-born baby, and of considerable value to it. Thus it is a concentrated, easily digested food, adapted to the needs of a newly-working digestive apparatus. It is also believed to contain *anti-bodies*, which, as already explained, help the infant to resist infections by germs, which it is now meeting for the first time.

The quality of the milk gradually changes, during the first weeks of lactation, from this early colostrum to the ordinary breast-milk.

The mode of onset of lactation is very variable. At the one extreme are found those cases in which the breasts fill gradually with milk and, apart from a slight feeling of fullness, the mother experiences no discomfort; the flow is well established by the third or fourth day, and the baby obtains a plentiful supply without difficulty. At the other extreme the filling of the breasts may be fairly sudden, and the accumulation of milk in the breasts may cause swelling, hardness, and great tenderness. This may occur from the second day onwards, but

seldom lasts more than twenty-four hours. As soon as the flow is established the unpleasant symptoms subside; the hardness and 'knottiness' of the breasts disappear, sometimes rather unevenly, outlying areas of the breast tissue remaining firm and tender for a day or two. Between these two extremes there are any number of intermediate variations; they must all be looked upon as normal and need not give cause for anxiety.

THE NATURE OF BREAST-MILK.

Food-stuffs, as is more fully explained in other sections of this book, are divided by the chemist into three main groups, known as Proteins, Carbohydrates, and Fats. The presence of all these three substances is essential in a diet if health is to be maintained. All are present in milk.

Of the three classes of food-stuffs, Carbohydrates, Proteins, and Fats, the first is the most easily assimilated and the most readily used as fuel. It is not surprising, therefore, to find it preponderating in breast-milk. Human milk contains 7% of carbohydrate, all in the form of milk sugar or lactose.

If given in excess of the immediate needs of the body for fuel carbohydrates are converted into fats, and stored as such. It is in this way that a child, or adult, fed on excess of starch or sugar will gain weight. This extra weight does not consist of muscle or bone, but of excess fat, which gives the body the characteristic pale, flabby appearance. This distinction is not sufficiently well appreciated by the public, and accounts for the success which many patent body-foods enjoy. The baby's weight is seen to be increasing rapidly, and this is interpreted as healthy growth, whereas it is merely an increased storage of redundant carbohydrate in the form of useless and eventually burdensome fat.

The protein content of human milk is 1·5%, and consists of two types of protein, one of which forms curds in the stomach, and is known as *casein*, whilst the other, which does not coagulate into curds in the stomach, is known as *albumen*. The latter preponderates considerably in human milk.

The fat content of human milk is 3·5%. This figure represents an average, for actually the fat content of human milk varies considerably in different individuals. There is very little evidence that the fat content of any one woman's milk can be much altered by changes in her diet.

The chemical composition of an average sample of human milk may thus be summarized:

SUGAR (lactose) . . .	7 %
FAT	3·5%
PROTEIN	1·5%

In addition to these three classes of food constituents, human milk also contains vitamins, or accessory food substances. The presence of these substances is essential to healthy growth, the absence of any one of them over a period of time resulting in a characteristic disease. Examples of such diseases are afforded by rickets, due to the absence or insufficiency of Vitamin D from the diet; and scurvy, due to the absence of Vitamin C. The presence of the necessary vitamins in breast-milk depends upon the mother's diet and hygiene; if the mother's diet contains a sufficiency of the vitamins they are secreted in the milk. Thus the milk of a mother who includes in her diet a daily ration of fresh milk, butter, eggs, and animal fats, will contain sufficient Vitamin D to protect her infant from rickets. On the other hand, rickets is not uncommonly seen in the infants of poor mothers who substitute margarine for butter, skimmed condensed milk for whole fresh milk, and to whom eggs and meat are rare luxuries.

FREQUENCY OF FEEDING.

The old practice of feeding at short intervals has now happily fallen into disrepute, and emphasis has rightly been laid on the importance of a regular rhythm in the feedings. These may take place either at three-hourly or at four-hourly intervals throughout the day, with an eight-hour rest for both mother and infant at night. This regularity of feeding is of obvious advantage to the mother; the infant may at first appear to resent such a regime, and it not infrequently happens that an inexperienced mother will feed her infant at all hours of the day and night in an effort to prevent crying. That the effort is usually fruitless need hardly be said; for the child experiences all the internal discomfort which an adult would undergo if he indulged in square meals at short and irregular intervals throughout the day. In fact, the infant is potentially a creature of habit, or, in modern scientific phrase, of conditioned reflexes. If a regular regime of feeding is imposed and strictly followed out, he very soon adapts himself to this as to other factors in his new environment.

Whether this regime should be three-hourly or four-hourly feeding matters little to the average healthy baby. Both have their advantages. The four-hourly regime, feeding at say 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m., gives the mother leisure for other duties or for relaxation. Most normal babies are able in five feedings to take sufficient nourishment for their needs, and the four-hour interval ensures that the stomach is empty of one meal before the next is started, and that the digestive glands are prepared for their work.

The three-hourly regime, feeding at 6 a.m., 9 a.m., 12 noon, 3 p.m., 6 p.m., and 10 p.m., is necessary for small infants with small stomachs,

or weakly infants who do not suck strongly. It is also necessary where the supply of breast-milk is small.

The maintenance of lactation is dependent upon two factors, the stimulus of sucking at the breast, and the emptying of the breast. It will be clear, therefore, that on the three-hourly regime the breast is sucked six times, whereas on the four-hourly regime only five feeds are given. On the other hand, the child is more likely to empty the breast four hours after its last feed, than three hours after.

The eight-hour rest at night is of the utmost importance to both mother and child, and need never be interrupted with a feed in the case of a normal infant. With very small premature babies night-feeding is necessary.

It is usual to give both breasts at each feeding; in this way only the first breast given will be completely emptied, and it is therefore important that the breast which is given first at one feeding should be given second at the next. Usually ten minutes at each breast suffices; but circumstances, such as have already been mentioned, may arise which call for modification of this routine. No hard and fast rules can be laid down, but as stated already, the average baby will thrive on five four-hourly feedings of ten minutes on each breast, with an eight-hour rest at night, and such a routine gives the mother the maximum of comfort and leisure. With healthy babies of average weight such a regime can be embarked upon from the second day of life. During the first twenty-four hours, both mother and infant require rest, and six-hourly feeding during this period is the rule.

QUANTITY OF FEEDS.

Normally it is not of any great importance or interest to the mother or nurse to know what quantity of breast-milk the infant is taking, and actually the amounts taken by a healthy infant are subject to very wide variations. If the infant is contented and gaining weight satisfactorily, and if there are no signs of digestive upset as judged by the nature of the stools, it may safely be assumed that the quantity of breast-milk is correct. Indeed, it is wise as well as safe to assume so, for the alternative is to 'test-weigh' the infant; and not only is this a somewhat laborious process, but its results, if not correctly interpreted, are often misleading, and a frequent cause of unnecessary worry on the part of an over-anxious mother, with resulting diminution in her milk-yield. If the infant is obviously thriving, test-weighing is definitely contra-indicated. Its chief application is in those cases where there are symptoms pointing to an insufficiency of breast-milk. The technique of test-weighing, and the interpretation of the results, will be described in a later paragraph. It will suffice for our present purpose to say that the baby is weighed accurately before and after feeding, the difference in the weights

being the weight of milk sucked at that feed. This process is repeated at every feed, and the total intake of breast-milk during the day is thus arrived at.

By making such investigations concerning many thousands of healthy infants of all weights and ages an average figure for the nutritional needs of the normal infant has been arrived at. This is found to be about two and a half ounces of breast-milk during the day for every pound of the baby's weight. That is to say, a ten-pound baby requires about twenty-five ($2\frac{1}{2} \times 10$) ounces of breast-milk during the day. A fifteen-pound baby would require thirty-seven and a half ($2\frac{1}{2} \times 15$) ounces of breast-milk in the day. It must be remembered that this is only a very rough guide. It is an average figure, and many healthy infants do in fact gain weight normally and keep perfectly fit on very much less nourishment than this average figure indicates.

As the infant grows he is less liable to suffer loss of heat through his skin, and it is found that his food requirements are correspondingly less, so that, at the age of six months the normal infant requires in food value little more than two ounces of breast-milk per pound of his body-weight.

At about this age of six months, however, a new factor comes in. The infant is now beginning to make more vigorous movements, and to take an appreciable amount of exercise, so that additional rations are needed as fuel to provide for this increased output of energy. The infant's food requirements begin to rise again, so that at nine months of age he once more needs an amount of food corresponding to about two and a half ounces of breast-milk per pound of body-weight. It is not usual for all this energy to be provided by breast-milk, other foods having been introduced by the time the child is nine months old. It is clear, therefore, that at this age and onwards some other unit of food value than a given volume of breast-milk is required to assess nutritional requirements. This brings us to the *calorie*, which is a unit of heat, and therefore of energy; it expresses the fuel value or energy-producing value of any given food. Thus one ounce of breast-milk is found to have an energy-producing value of twenty calories. We may therefore recapitulate the statement of the infant's energy requirements as follows; at birth an infant requires fifty calories per pound of body-weight—a seven-pound baby requires three hundred and fifty calories; at six months the energy requirement has fallen to a little over forty calories per pound of body-weight, and rises to fifty calories again at the age of nine months.

The importance of these facts becomes clear when attempts are made to design an artificial diet for the young infant. If the calorie-values of the various ingredients are known there is no difficulty in ascertaining the total food-value of the diet. Certain widely used systems of infant

feeding are based on such calculations, and their principles cannot be well understood without some conception of the meaning of the fuel-value of foods and of the calorie, which is a measure of this fuel value, as the shilling is a measure of monetary value.

THE TECHNIQUE OF BREAST-FEEDING.

Just as one of the most important factors in successful breast-feeding is the mental comfort and freedom from worry of the mother, so in the successful management of the individual feed her bodily comfort and that of her infant are first considerations.

During the first ten days the mother will have to feed her baby while lying in bed, and she will therefore need the assistance of a nurse or attendant. The mother should lie on her side supported in a comfortable position by pillows. The nipple should then be gently cleaned with water and a soft linen rag or piece of gauze. The baby is then brought to the mother and lies parallel to her in the bed, in such a position that the nipple falls into the infant's mouth. The rest of the breast is kept clear of the infant's nose by the mother's upper or free hand, the first and second fingers being placed one on either side of the areola, or pigmented area of skin surrounding the nipple. When the infant has emptied the first breast he should be held up over the shoulder of the attendant in order to give him an opportunity to bring up any wind he may have swallowed, while the mother arranges herself in comfort on the other side ready to complete the feeding with the second breast. At the end of the feeding the infant is again held up, and then returned to his cot. This second holding up may well be done by the mother, but prolonged 'dandling' or rocking to and fro is not only liable to make the infant vomit part of the feed, but inculcates bad habits, so that the child begins to expect such 'nursing' after the feeding, and will not settle down to the sleep which should naturally follow feeding. At the end of feeding the nipples should again be cleaned and dried, and covered with clean linen, so as to prevent contact with the clothing.

An equally definite routine should be followed when the mother is up and about. Quiet and comfort are essential. It is asking for trouble to attempt to breast-feed an infant just anywhere. A low chair should be used, and the baby should rest on the mother's lap supported by one arm. The knee on the same side as the breast to be used may be raised by placing the foot on a stool. A glass of water may be placed on a table within reach and drunk by the mother during the feeding. The object of embodying this in the routine is to ensure that the mother has an adequate daily fluid intake. There is no particular virtue in taking this extra fluid at the times of feeding, but if not done at this time it is easily forgotten, and a sufficient intake of water is an important factor in successful lactation. The room in which the feeding

takes place should be quiet, and the mother should be free from disturbance, so that she can give her whole attention to the infant.

The mother should sit slightly forward so that the nipple and surrounding areola may be easily directed by the free hand into the infant's mouth. In all other respects, the technique of feeding is similar to that followed during the early days while the mother was still in bed.

MOTHER'S DIET DURING LACTATION.

Little need be said on this matter, as it is now generally agreed that a nursing mother should take the food, both quantity and kind, that ordinarily suits her best. From time immemorial the virtues of various foods, drinks, and medicines have been extolled for increasing the supply of breast-milk. They are known as galactagogues, but it is doubtful if such things, in fact, exist. Avicenna, an Arabian physician of the eleventh century A.D., recommended a decoction of earthworms in barley-water or the heads of flying-fish steeped in dill-water. In the sixteenth century faith was placed in a preparation of dried cow's tongue or neat's tongue, poached eggs, and a great variety of herbs. In more recent days the value of oatmeal stout as a galactagogue has been proclaimed. The truth is that all these alleged remedies for a deficient milk-supply act by suggestion; the diminution in milk output being most commonly due to the mother's worrying.

Apart from fluids, then, a nursing mother should take what best suits her palate and her digestion. It may be borne in mind, however, that the supply of vitamins in the breast-milk is dependent on the mother's intake of these substances.

The taking of alcohol-containing drinks during lactation is a subject upon which strong views have been expressed. The truth is that, taken in moderation, wines and beers do not affect either the quality or the quantity of the breast-milk. A woman who is in the habit of taking a glass of wine or beer with her meals may find her digestion or her peace of mind impaired by the sudden discontinuance of this aid. She may without harm continue in her habit. On the other hand if a woman is not accustomed to take alcoholic drink she should in no circumstances be persuaded to take it during lactation.

The regular action of the mother's bowels during lactation is of importance. This regularity is sometimes disturbed owing to the loss of fluid through the secreting breasts, and may usually be restored by a slight increase in the fluid intake. If, on a reasonable diet and sufficient fluid intake, constipation is still troublesome, mild laxatives may be used. Strong purgatives are best avoided.

DIFFICULTIES OF BREAST-FEEDING.

Difficulties in the course of breast-feeding may be due either to the mother or to the child.

Under the former heading may be placed complications arising from too liberal a supply of milk or from too little milk; natural abnormalities of the breast; engorged and painful breasts; cracked and sore nipples; and breast abscess.

OVERFEEDING ON THE BREAST.

Is perhaps the commonest cause of disturbance in the breast-fed infant. Its commonness is largely due to the fact that it is rarely suspected by the mother in its early stages. At the onset of overfeeding the infant not only continues to gain weight, but may for a while gain at an increasing rate. This should be the danger signal, but it is one which is seldom heeded even by quite intelligent mothers. Many appear to think that their infant can in this way build up a reserve of weight 'against a rainy day,' and are only disillusioned when the continued overfeeding results in the inevitable dyspepsia with an accompanying loss in weight, often difficult to check. An early symptom of overfeeding is crying shortly after the feeding, which is frequently misinterpreted as a cry of hunger. Actually it is the cry of discomfort occasioned by the overcharged stomach. This overfilling of the stomach may result in vomiting, and the vomiting may serve to protect the infant from the more severe forms of dyspepsia which result when the excessive feeds are allowed to pass through and overtax the rest of the intestine. At the same time the vomiting may be excessive, with the net result that the infant is not receiving enough food for his body's needs.

Crying after feeds and vomiting are early symptoms of overfeeding. If, in the absence of, or in spite of, this protective vomiting, excessive food is passed on from the stomach to the bowel, diarrhoea commonly results. The stools lose their normal consistency and yellow colour, and become green and watery, and are accompanied by the passage of slime or mucus, due to the irritation of the mucus-secreting glands of the bowel. The passage of food through the bowel is normally accompanied by the absorption of water, so that by the time the food residue reaches the lower bowel it has become less fluid, and assumes the characteristic pasty consistency of the normal stools. When the bowel is irritated, whether by excess of food or by unsuitable food, it acts for its own protection in the most natural way, by trying to get rid of the cause of the irritation. In this way the food is hurried along the bowel, and there is no time for the normal absorption of water to take place. The characteristic watery, frequent stools of overfeeding result. These stools may also contain portions of undigested food in the form of curds. If untreated, overfeeding may give rise to very severe wasting disease. In its milder forms it is, as has been said, probably the commonest form of digestive upset to which the breast-fed infant is liable. The treatment of the condition in its early stages is simple, and consists in curtailing the length of the breast-feeds. It is a constant

source of surprise to mothers to find in how short a time a healthy baby may extract adequate nourishment from some breasts. Babies have been known to suck as much as seven ounces of breast-milk in three minutes. If mere shortening of the times at the breast is not sufficient it may be advisable in such cases to resort to feeding on alternate breasts, only one breast being given at each feeding. It is frequently useful to give boiled water immediately before the breast-feed in order to slake the infant's thirst, and so reduce the rate of sucking. Up to two or three tablespoonfuls of boiled water may be so given, and is best administered by spoon; if the spoon is refused a bottle may be used. When persistent overfeeding has resulted in severe diarrhoea and loss of weight a doctor's advice should be sought. It will usually be necessary to rest the bowel completely by giving water only for twelve to twenty-four hours; and the breast feeds, when resumed, will have to be very short at first, in order not to overtax the irritated bowel. However severe such a digestive upset may be, it is never to be taken as an indication for weaning. Indeed, the more severe the upset the greater will be the recovering child's need for the most easily digested of all infant foods, namely, breast-milk.

UNDERFEEDING ON THE BREAST.

This condition is not nearly so common as the foregoing, overfeeding, and is not so serious in its consequences. Nevertheless, a fear of underfeeding her baby is, perhaps, the commonest cause of anxiety in the nursing mother. Conversely, the commonest cause of a diminution in the supply of breast-milk is anxiety on the mother's part.

Happily it is usually only a temporary difficulty, and in cases where the mother can be persuaded of this the milk is soon found to increase in quantity.

There are, however, cases in which the supply of breast-milk, for longer or shorter periods, sometimes throughout lactation, is insufficient to supply the nutritional needs of the infant. In such circumstances the infant shows signs of hunger, that is to say, he cries, usually before the next feed is due. Sometimes the crying occurs immediately after the feeding, but more usually crying is delayed. It is impossible to describe the cry of a hungry child, but it differs markedly from the cry of discomfort which follows the feed in the case of the overfed child. A valuable guide is afforded by the weight chart. An underfed infant will not gain sufficient weight; a word of warning is here needed as an overfed child may, as has already been pointed out, lose weight to an equal extent. Still, in conjunction with other symptoms, a progressive loss in weight may be taken as evidence of underfeeding. The stools of an underfed baby depend to some extent upon the degree of the fault. They may be normal, but where underfeeding is consider-

able the typical 'hunger stools' appear. These consist of small, very dark brown or green stools, usually solid or semi-solid in consistency, accompanied by mucus, and passed four or five times a day.

The underfed baby will, until underfeeding has been so long continued that general constitutional weakness has resulted, usually suck voraciously at the breast. The treatment therefore consists primarily in increasing the supply of breast-milk.

INCREASING THE SUPPLY OF BREAST-MILK.

The most important measure for promoting this end consists in allowing the infant to stimulate and to empty the breast at regular intervals. If the baby is on the usual four-hourly feeds, the routine may be changed to three-hourly feeds, and both breasts should be used at each feed. After the feeding the breast should be 'stripped,' that is to say, emptied manually. This is achieved by grasping the breast firmly between the thumb and forefinger and exerting steady, but not painful, pressure towards the nipple in a 'milking' movement. The ducts containing the milk are in this way emptied mechanically. This is only necessary in those cases in which the breast has not been emptied by the infant's sucking. If the breasts are tender the emptying may be achieved, but usually not so completely, by the use of the breast-pump. Massage is of great value. This is best carried out by a nurse, but may be done by the mother herself. Twice a day the breast may be rubbed by hand, the rubbing being always towards the nipple. Alternate hot and cold sponging is also sometimes helpful. Two basins are needed, one containing hot and the other cold water, two sponges are used, and the breasts, supported by the hand, are first sponged with the hot and then with the cold water. This is followed by vigorous rubbing with a rough towel.

Chronic underfeeding is as undesirable as chronic overfeeding, and, if persistent, must be met by *complementary* feeding, that is to say, the giving of an artificial feed *after* the breast-feed. The details of making-up the artificial feed will be discussed more fully in the section dealing with that subject. Certain aspects, however, may here be usefully considered.

THE TEST-FEED.

The only accurate way of determining the quantity of extra nourishment to be given to an infant who is being underfed on the breast is to carry out a series of test-feeds. For this purpose an accurate pair of scales furnished with a set of weights is essential. Spring balances are never to be relied upon for this purpose. The baby, dressed in its ordinary clothes, is weighed to the nearest quarter of an ounce. It is then given a full breast-feed, every effort being made to induce the

infant to empty the breasts. After the feed the child is again weighed, no change being made in the clothes; if a napkin has been soiled during the feed this must not be changed until after the second weighing. In this way the weight of milk obtained from the breasts during the feed is ascertained to the nearest quarter of an ounce. If the infant has left any milk in the breasts this should be expressed by hand, and measured in a medicine glass. The process is repeated at every feed throughout the day. It is found that in the case of normal fully breast-fed infants there are very considerable variations in the amount of milk sucked at each feed; the biggest feed is usually the first feed in the morning. On this account an accurate result can only be obtained by carrying out test-feeds throughout the day. In practice, however, and especially where the mother cannot test-weigh at home, and the clinic or welfare centre has to carry out the work, two test-feeds are done, and the total daily output of milk calculated from these two observations.

In this way an indication is obtained of the amount of artificial complementary feed that is needed to ensure that the infant gets sufficient nourishment.

COMPLEMENTARY FEEDING.

The complementary feed is an artificial feed given directly after the breast-feed. In most cases it is to be regarded as a temporary measure which will be discontinued when the supply of breast-milk is again sufficient. This attitude of mind towards the complementary feed is of importance as it serves to remind us that the true treatment of under-feeding on the breast is to increase the breast-milk supply. It is for this reason that the breast is always given before the complementary feed in order that the hungry baby may stimulate the breast by vigorous sucking and by emptying it.

The quantity of the complementary feed is of importance, and is based, as already explained, upon the results of test-feeds. Even so, in the case of a normal healthy baby it is unwise to make up the full nutritional requirements with artificial feeds; it is usually better to keep the quantity of extra food low so as to maintain a healthy appetite for the breast. It is not uncommon to find babies who have been given complementary feeds weaning themselves from the breast. This is often due to the extra feeds being too large, so that the baby is not sufficiently hungry when next put to the breast; as a result the sucking is feeble and insufficient to stimulate the breast to increase its supply. Test-feeds carried out at this juncture may show an actual diminution in the supply of breast-milk, and this is made a reason for a further increase in the artificial feeds. In this way a vicious circle is set up which ends only when the child is fully artificially fed.

Another factor which contributes to this state of affairs is the com-

parative ease with which an infant sucks milk from a bottle. It has been shown that more exertion is needed to get milk from a breast than from a bottle. The lazy infant will frequently learn to prefer the bottle-feed to the breast-feed, and refuse to suck at the breast. This can usually be prevented by the use on the bottle of a hard-drawing teat, that is to say, a teat with a very small hole, through which the milk will only drop at about the rate of one drop every four or five seconds.

A further difficulty may arise through the artificial feed being sweeter than the breast-milk, and the infant preferring it on this account. This is especially true where sweetened condensed milks are used for complementary feeding, and on this score they are quite unsuitable. It is not proposed to enter into the details of the constitution of artificial feeds, but it will suffice to say that where the artificial feed is being used as a complementary feed the proportion of sugar should be kept lower than would be the case if the feeding were entirely artificial. It is in complementary feeding that such sugars as lactose or dextro-maltose have their chief use, as they are less sweet than cane sugar, while being at the same time no less nutritious.

It may not be necessary to give the complementary feeds after every breast-feeding throughout the day. In these circumstances the most convenient practice is to give the bottle after the last two or three breast-feedings. This system usually works well and ensures a sufficient quantity at the last feed to enable the child to sleep through the eight-hour night interval. It is not often necessary to give a complementary feed after the first morning feeding, as test-weighing may show that this is the largest of all the feeds and sufficient for the infant's requirements. In cases of difficulty test-weighings are carried out throughout the day, and the complementary feed given after the smaller feeds. Many infants are found to suck sufficient for their needs at the first and last feeds. In such a case to complement the last feed would over-fill the baby, and make for an uncomfortable night. It is better in such an event to give the complementary feed after one of the earlier breast-feedings.

SUPPLEMENTARY FEEDING.

This implies the giving of an artificial feed *instead* of a breast-feed. As a routine method of part breast-feeding, it is to be condemned; its practice almost invariably resulting in a diminution in the supply of breast-milk and rapid weaning. This is due to the lack of regular stimulation of the breast which supplementary feeding involves; it is in fact the method by which weaning is normally accomplished at the end of lactation. Unfortunately the practice is still widespread among mothers who imagine that they are thereby increasing their breast-milk supply. To rest the breast in the hope that it will thereby become more

full of milk for the next feed is quite fallacious. Supplementary feeding, however, is legitimate in those cases where it is economically impossible for a mother to give the breast at every feed. Thus a mother who was anxious to breast-feed her baby but was engaged in a theatrical production which involved two matinée performances each week, successfully fed the baby while substituting two supplementary feeds per week. In this case the hours of feeding were 7 a.m., 11 a.m., 3 p.m., 7 p.m., and 11 p.m., and on two days a week a supplementary feed was given at 3 p.m. Though not to be regarded as an ideal method, supplementary feeding in such a case is a necessity, the alternative being complete weaning of the infant. In the later months of lactation an occasional supplementary feed does not the slightest harm, and permits the mother to enjoy social activities which would otherwise be impossible.

DIFFICULTIES DUE TO ABNORMALITY OF THE BREASTS.

Breasts vary very much in both size and shape, and it is impossible from its appearance to say whether any given breast will be satisfactory in its milk-producing properties. The breast is made up of glandular tissue, which produces the milk, and supporting tissue. A large breast may consist largely of supporting tissue, and therefore produce a poor secretion; on the other hand a small, flat breast is often found to yield a large supply of milk, being composed almost entirely of glandular secreting tissue, and deficient only in the less important supporting structures.

A large pendulous breast may cause difficulty in suckling owing to its obstructing the infant's nose, and thus preventing breathing during the feed. In such a case special care must be taken by the mother to hold the breast away from the infant's face with her disengaged hand.

Depressed and Small Flattened Nipples sometimes give rise to real difficulty in nursing as the baby cannot get a firm grip of them. The shape of such nipples can be greatly improved during the later months of pregnancy by drawing them out gently with the finger and thumb every day, and the same treatment should be applied after the birth of the child. Every effort should be made in such cases to get the infant to suck, as this is the most effective cure of the condition. The infant's efforts may be aided after the feed by judicious use of the breast-pump. It is essential that the nipple should be drawn out sufficiently for the infant to grasp it before the breasts fill with milk, as even a slight degree of engorgement of the breast will make the flattened nipple still more inaccessible to the infant's mouth, and the natural relief of the engorgement, namely, the infant's sucking, will then not be available.

Engorgement of the Breast may be general or local; that is to say, the whole breast may be involved or only one or two lobules of the gland may be affected. When the whole breast is tense and painful the cause

is usually a rapid production of milk with inefficient sucking on the part of the infant. This poor sucking may be due to a weakly infant or, as has been said, to malformed nipples. In either case the use of a breast-pump is indicated to relieve the tension in the engorged organ.

Where only one or two lobules are affected these stand out as hard, knotty lumps, usually in the outlying positions of the gland and most commonly in the lower and outer quadrant. The condition is usually due to blockage of one of the milk ducts, and gives rise to considerable pain and tenderness in the affected region. The blockage can often be relieved by sucking, either by the infant or by the pump. The pain is greatly lessened by supporting the breast in a bodice or bandage which lifts the breast up without pressing it back. Hot fomentations should be applied to the affected area, but care must be taken not to apply the fomentations over the nipple itself, as this tends to make the skin over the nipple soft and liable to infection.

Breast Abscess. If the obstruction of the ducts remains unrelieved the local engorgement may lead on to infection of that part of the breast, and ultimately to the formation of a breast abscess. A breast abscess, like an abscess anywhere else in the body, consists of a collection of pus or matter walled off completely from the structures which surround it. This process of walling-off, which is known as *localization*, is a desirable state of affairs, and is favoured by resting the breast in a suitable support and by hot fomentations. Once the abscess is localized it is necessary to let out the pus, and this has to be done by means of the surgeon's knife. Engorgement of the breast is therefore a serious condition, and one which even in its early stages demands medical attention. Owing to the pain associated with breast abscess it may be necessary for a while to cease feeding the baby from the affected breast. The other breast should still be used.

The infant should be put back to the affected breast as soon as possible after the abscess has been drained. This will not as a rule be for some days, as suckling will be too painful.

Cracked Nipple. The danger of softening the nipple by the application of hot fomentations has already been mentioned. Such softening may also be the result of a want of care in drying the nipple after feeding, or of allowing the infant to go to sleep during feeds with the nipple in his mouth, using the nipple as a dummy. By such means the skin of the nipple may easily become softened and 'water-logged,' and cracks then occur, similar to the cracks that may occur in the lips during cold weather. Such cracks are often extremely painful and may even necessitate temporary discontinuance of suckling. When they arise their treatment sometimes presents difficulties. The object of treatment is to disinfect the cracks and to cover them. Foı this purpose friar's balsam is the most useful application. The balsam is wiped

off before putting the baby to the breast. Such treatment usually suffices to effect a cure in the course of a few days. Some cracked nipples are, however, more resistant to treatment, and medical advice should then be sought. In obstinate cases additional rest to the cracked nipple is afforded by the use of soft-rubber nipple shields during the feedings. Some babies, however, refuse to suck through such a shield, and it may be necessary to discontinue the use of that breast for some days. Gentle expression of the milk is then needed to prevent engorgement. The expressed milk may be fed to the infant in a spoon. Besides being painful, a cracked nipple, if neglected, may give rise to a breast abscess.

DIFFICULTIES OF BREAST-FEEDING DUE TO THE INFANT.

The baby may be so feeble, owing to prematurity or other cause, as to be unable to suck at the breast. If able to suck, it may be unwise to allow him to do so owing to the exhaustion which results. The treatment of such a situation will be dealt with when the care of the premature child is considered. The infant may be unable to suck owing to disease or malformation of the mouth. The latter conditions will be obvious, but it may here be emphasized that a painful inflammation of the mouth, commonly due to infection with the fungus of thrush, is a frequent cause of refusal and of crying at the breast, and may easily be overlooked.

If the infant cannot breathe freely through the nose, sucking will necessarily be intermittent and difficult. The most frequent cause of nasal obstruction at this age is a mild catarrhal infection, which is best treated by clearing the nose with an alkaline lotion made of a teaspoonful each of common salt and bicarbonate of soda dissolved in half a pint of warm water. Persistent nasal obstruction should be referred to the doctor for treatment. Shortness of breath similarly calls for medical advice.

Apart from such organic conditions as have been already mentioned, a few physically sound babies are difficult to feed at the breast owing to restlessness and crying. They are said to be 'breast-shy,' and cry and turn their heads away whenever they are brought to the mother's breast. In some cases this is due to faulty suckling technique at the start, the infant having been confronted early on with an engorged breast and flattened nipple, or a too rapid flow of milk having caused him to choke. There is, however, a certain proportion of such breast-shy cases in which the cause is obscure. In any event the treatment is the same. The mother must remain calm and assured that her infant will eventually settle down. This is often difficult but is essential to success, as nervousness and worrying on her part easily communicates itself to the breast-shy infant, and will tend also to diminish the flow of milk. Some reassurance may be gained by the knowledge that in the early days of

life the infant's food requirements are small; and that, provided sufficient water is given, the infant is rarely in danger from starvation. Artificial feeding is thus the worst possible treatment for such cases. The infant who is breast-shy should be kept hungry, but not thirsty. Daily weighing will then show a normal weight curve. Four-hourly feeds are usually more satisfactory than three-hourly. The feeding should be carried out in a quiet room which has been darkened, as this helps to calm a restless child. The infant should be wrapped rather firmly in a shawl, as this also tends to soothe him. Sedative medicines may in some cases be advantageously employed, but only under a doctor's supervision. At the start of the feed milk may be expressed from the breast into the infant's mouth, and the nipple moistened with expressed breast-milk. Patient, firm management is the key to success in this type of case. A wise and experienced nurse is often of the greatest help.

ARTIFICIAL FEEDING OF INFANTS.

The feeding of infants deprived for any reason of breast-milk is a problem which parents often find perplexing. Their perplexity is due to the wide variety of methods at present advocated, to the regrettably impassioned zeal of their advocates, and to the apparently uniform excellence of the results obtained. A sober consideration of these facts, making due allowance for the exaggerations of enthusiasts and the downright lies of advertisers, leads the more thoughtful to the conclusion that the young of the human species is in the matter of diet peculiarly adaptable. Nor is this a matter for great wonder when one considers that it is his adaptability—in dietetic and other matters—that has placed man in his present position at the head of the animal kingdom. It is due to this power of the infant to accommodate himself to a considerable variety of circumstance that no one can give an unqualified answer to the conscientious parent's oft-repeated question: 'What is the *best* artificial food for an infant?' There is no best. Experience of feeding methods has, however, led to certain conclusions with regard to the average infant's needs and capabilities, and it is our object here to present these conclusions and to indicate broadly how the infant's needs may be met without overtaxing his capabilities. In this connection it should be remembered that it is not often possible to judge the suitability of a diet from its immediate effects; an infant who appears to be thriving may later show signs of deficiencies on the very diet which appeared earlier to be suiting him so well. For this reason the only advice worth following in matters of infant feeding is that based on wide experience; the alleged successful feeding of half a dozen infants on any food, patent or otherwise, is not enough to warrant the adoption of that food. Only those methods which have been tested by competent

observers on many thousands of infants shall be considered; even so there is a sufficiently wide choice.

Most artificial feeds have as their basis cow's milk. The advantages of this in readiness of supply, cheapness, and adaptability to the infant's needs far outweigh its disadvantages, so it will be assumed that the artificial food is to consist, in part at least, of cow's milk.

Grades of Milk. Cow's milk is sold to the public under the following designations:

Certified milk, the most expensive form of milk, is raw milk bottled on the farm, produced under conditions which ensure cleanliness, from cows examined by a veterinary surgeon, and tested for the presence of tuberculosis every six months. In addition the numbers and types of germs found in the milk on examination under the microscope are regulated.

Grade A, T. T. (tuberculin-tested) milk is produced under similar conditions, but a larger number of germs is permitted.

Grade A milk is similar to Grade A, T. T. as regards the limits placed on its germ-content, but no test for tuberculosis is applied to the cows, which are examined by the veterinary surgeon every three months instead of six.

Pasteurized milk is milk, supervised as to its content of germs, which has been kept at a temperature of 145° to 150° F. for half an hour.

The danger of milk as a food for infants lies in the germs which it contains, and especially in the possible presence of the germs causing tuberculosis. These germs are destroyed by boiling the milk, and this is a procedure which the present writer strongly advocates. There is, however, a certain number of well-informed people who oppose this view, the grounds for their opposition being that boiling milk destroys the vitamins together with certain ferments which aid the digestion of the milk. That the vitamins are in part destroyed is true; but they can readily be replaced from sources uncontaminated with the germs of tuberculosis. Moreover, the vitamin content of milk varies very greatly, and is not to be relied on as a sure protection from the deficiency diseases. The presence of digestive ferments in the milk is conjectural; their existence is not a proved fact, whereas the presence of harmful germs is; furthermore, the increased digestibility of cow's milk after boiling is incontestable.

The Composition of Cow's Milk. Cow's milk, like human milk, contains Protein, Fat, Carbohydrate, Minerals, Vitamins, and Water. It differs from human milk in the proportions of these ingredients and in their nature.

The *Proteins* of cow's milk amount to about 3·5% of the whole, whereas in human milk they are but 1·5%. Moreover, milk proteins

are of two classes: casein, which forms curds, and albumen, which does not. The former is more difficult to digest than is the latter. While in human milk the casein is in relation to the albumen as 1 to 2, in cow's milk the ratio is as 4 to 1. As a result the clot formed when the milk enters the stomach is much larger and tougher in the case of cow's milk.

The *Fat* content of cow's milk is the same as that of human milk, namely, 3·5%. The nature of the fats is somewhat different, and that of cow's milk is slightly less digestible. The fat content is likely to be constant if the pooled milk of a large herd is used; this is an argument against keeping an individual cow to supply an infant's needs. Jersey cows supply a rich milk with a high fat content, which makes it less suitable for infant-feeding than the milk of shorthorn cows.

The *Carbohydrate* of cow's milk is identical with that of human milk, and is all in the form of lactose or milk sugar. It is present, however, in less quantity, namely, 5%.

The *Mineral* content of cow's milk consists chiefly of combinations of calcium, sodium, iron, and phosphorus. Their total proportion is higher than is that of the minerals in human milk. The iron salts may, however, be deficient, and this may give rise to anaemia in artificially fed babies unless iron is added to the diet. This is a point which will be dealt with later. The proportions of the various constituents of cow's and human milk may usefully be contrasted thus:

	Human	*Cow*
PROTEIN (Clotting)	0·4	3·1
,, (Non-clotting)	1·1	0·4
TOTAL PROTEIN	1·5	3·5
SUGAR	7·0	5·0
FAT	3·5	3·5
SALTS	0·2	0·7

It will be apparent from a study of the figures above that by no degree of dilution can cow's milk be converted into human milk. The claim to 'humanize' milk can therefore no longer be rightly made. It is found, however, that whole raw cow's milk is not a suitable food for the average normal baby, so some form of modification is necessary, and the primary object of this modification is to present the protein of the milk in a more easily digested form.

Protein indigestion is less likely to occur if the protein is given to the child in small quantities and in a finely divided state, similar to the fine curds formed by breast-milk in the human stomach. The first of these two objects may clearly be achieved by diluting the milk with water. If a mixture of equal quantities of milk and water is made the

as will restore the nutritional value of the milk and water mixture without materially increasing its bulk. Such addition of sugar and fat can be made without overtaxing the infant's capacity to digest these substances, since they are in diluted cow's milk below their level in breast-milk. A concrete example may serve at this point to make things clearer. If a ten-pound baby has been given a mixture of equal parts of milk and water he will have satisfied his fluid requirements, which is another way of saying that he will probably have taken as much as he can comfortably hold, when it has had twenty-five fluid ounces in the day. But he will only have had twelve and one-half ounces of milk, or two hundred and fifty calories. His nutritional needs are five hundred calories; therefore he will be underfed. If, however, we were to add seventeen drachms of sugar to the mixture (one drachm of sugar has a nutritional value of about fifteen calories) we should, without increasing its bulk, have added about two hundred and fifty calories of nourishment, and the baby would then be having an adequate diet as far as the total nourishment was concerned. (This mixture would, in fact, be quite unsuitable for any child.) It is with this idea of restoring the nutritive value to the dilute milk mixture that sugar is added. The quantity of sugar which it is necessary to add naturally depends upon the degree of dilution of the milk, and also on the quantity of fat, in the form of butter, cream, cod-liver oil, or one of the compounded 'creams,' which is embodied in the mixture. As to the type of sugar used there is a wide choice. Milk-sugar or lactose is advocated on the plea that it is the *natural* sugar to give; the only disadvantage appears to be its cost. Glucose and dextro-maltose have their supporters, the former because it requires no digestion before absorption, and the latter because it is more rapidly assimilated than any other sugar; the advantage of these properties is not obvious. Cane sugar is widely used, and seems to be fairly satisfactory; it is readily obtainable in a high state of purity, and at a comparatively low cost.

From what has been said so far it would appear that the nutritional needs of an infant may be supplied by a simple mixture of cow's milk, water, and sugar. Inasmuch as the human body has the power of converting sugar into fat this is true (vitamins being added), and with children who, as the result of abnormality or disease, are unable to digest fat, such a procedure has sometimes to be adopted. The normal child should, however, have a certain proportion of fat in his diet; the reasons for this are, firstly, that fat of animal origin contains the essential vitamins A and D, the first of which is not only essential to growth but also protects against infections, while the second protects against rickets. Secondly, it is found in practice that an attempt to add

symptoms of sugar intolerance. In other words, the limit of the infant's capacity to utilize sugar is passed before his nutritional needs are supplied. For these reasons a complete food should have a proportion of fat, and the added fat should be of animal origin, as vegetable fats, such as olive oil and nut oils, contain no vitamins.

The quantity of fat to be included in a milk mixture must lie between, at the upper limit, the child's capacity to digest and absorb the fat, and, at the lower limit, that quantity which will contain adequate quantities of the fat-soluble vitamins. The capability to digest fat is very variable, even in the normal child, but it is important to remember in all cases that the fat added to an artificial feed differs from the fat of human milk, not only in chemical composition, but also in its physical state; that is to say, in the fineness of its emulsion. For fat occurs in milk as an emulsion or suspension of fine droplets in the watery solution of sugar and protein, and upon the size of these droplets depends to some extent the ease or difficulty with which the fat is digested.

The nature of the fat to be added is of some importance, and there is a wide choice. The cream of cow's milk has the disadvantage that, as at present sold in shops, it varies very widely in its composition according to whether it is prepared by skimming 'set' milk or by mechanical separation. If prepared by the former method it may be much contaminated by germs which have fallen into it during the 'setting' process. A further disadvantage of cow's cream is that it is as likely to be infected with harmful germs as is the milk from which it has been prepared; all the arguments against the use of raw cow's milk apply with equal force to the use of cream. If it is boiled in order to sterilize it the vitamins are in some measure destroyed.

Butter is sometimes used, but much the same argument applies.

The other available fat is cod-liver oil, and on account of its high vitamin content and its freedom from tubercle bacilli it has found wide favour. Its use, in some form, is one of the few procedures in infant feeding which has not been made a 'bone of contention' by the experts. As a result this valuable food has been used as the basis for an almost countless number of patent preparations which it would be tedious and fruitless to specify. The object of the makers of many of these compounds has been to modify the characteristic taste and smell of the oil which they contain. These properties of cod-liver oil, though nauseating to many adults, appear to have no such effect on the average infant, who will consume the necessary quantity of the oil with evident relish. A refined cod-liver oil is frequently an inert substance as far as its rickets-preventing property is concerned, and in practice it is wise to select an oil prepared by a reputable firm of chemists who have estimated its vitamin content, and publish the result of such estimation on the label of the bottle.

If the oil is to be added to the food in the bottle it is convenient to make use of an emulsion. This should contain 50% of the oil. Vitamin-containing creams, such as 'New Zealand Cream' and 'Marylebone Cream,' are also widely used. They possess the advantage of being solids which pack more easily and maintain their state of emulsion almost indefinitely. Furthermore, they contain sugar, which acts as a preservative. Their chief disadvantage is their price, which is greater than that of the simple emulsions. When using such preparations the percentage of vitamin-containing fat should be ascertained, as they contain a proportion of oils of vegetable origin. In addition, their sugar content must be allowed for when working out the proportions of a feed.

For the prevention of rickets a normal child of one month requires two teaspoonfuls, and a child of two months three teaspoonfuls, of the pure cod-liver oil a day.

Vitamin Concentrates. Recent research has resulted in the production of certain vitamins, notably A and D, in highly concentrated forms. Examples of such substances are 'Essogen' and 'Avoleum' (Vitamin A), 'Radiostol' and 'Ostelin' (Vitamin D), and 'Adexolin' and 'Radiostoleum' (Vitamins A and D). Properly used these substances mark a great advance in vitamin therapy, and are of inestimable value in certain types of case. They need, however, form no part of the diet of the normal child, and the concentrates of Vitamin D are not devoid of danger if used by the undiscriminating.

Vitamin D acts in the human body by facilitating the laying down of the mineral calcium in such places as the bones and the teeth where it is normally required. The ordinary diet of an infant contains plenty of calcium, but in the absence of Vitamin D this calcium is not properly used, and the bones become soft and bendable, giving rise to the characteristic rickety deformities. The results of over-dosage with Vitamin D are equally disastrous. In the presence of an excess of Vitamin D the deposition of calcium in the body is carried beyond the normal degree, and takes place in abnormal situations outside the bones and teeth, such as the kidneys. The writer has seen a case of stones in both kidneys resulting from gross over-dosage with a Vitamin D concentrate. Such preparations should not be used except on medical advice.

Vitamin C. This vitamin exists in the raw milk of pasture-fed cows. It is easily destroyed by heat in the presence of air, and must therefore be added to the diet of infants fed on boiled cow's milk, if scurvy is to be prevented. It is contained in the juices of citrous fruits, such as oranges and lemons, and it is essential that such juice should be given. Half a teaspoonful of orange juice may be given with an equal quantity of water every day to an infant a month old, and the amount increased as the child grows. This is usually well tolerated, and has no appre-

ciable effect on the child's digestive tract. It is interesting to note how large a proportion of mothers give the orange juice in the mistaken belief that its purpose is to keep the action of bowels regular.

If, as occasionally happens, the juice is not well taken, a valuable substitute can be prepared by baking a potato in its 'jacket.' The floury potato lying next to the skin is scraped from the skin with a spoon and made into a cream by the addition of a small quantity of milk. Three teaspoonfuls of such a cream during the day has a powerful anti-scorbutic effect.

The Feeding Bottle. There is no question that at its best the feeding bottle is a very great nuisance; at its worst it is a grave danger. Before the discovery of india-rubber the feeding bottle or bubby-pot was made in the shape of a teapot in pewter or china, with a sponge of twisted rag thrust into the spout. Through this wick the infant sucked his mixture of sweetened milk and small beer, to which must have been added a truly remarkable assortment of germs, which lived and multiplied in the depths of the insanitary teat. With the introduction of india-rubber teats and the principles of asepsis the feeding bottle became less of a germ trap, but for a time it was not uncommon to see the teat connected to the bottle by a long and uncleanable rubber tube.

The modern bottle is of two types. The 'Soxhlet' bottle is cylindrical and has a rubber teat at one end. The boat-shaped bottle is open at both ends, on one of which is placed the teat, and on the other a rubber valve, which allows air to enter the bottle as the milk is sucked out. It is claimed for this type of bottle that it is more easily cleaned than is the 'Soxhlet.' Certainly a stream of water can be directed *through* the bottle, but experience does not show that the other type of bottle presents any great difficulty in cleaning. The disadvantage of the boat-shaped bottle is that it has two rubber attachments instead of one, and as the rubber is perishable, especially when frequently boiled, this constitutes an added complication. The most obvious advantage claimed for the boat-shaped bottle lies in its rubber inlet valve. In unskilled hands this is not an unmixed blessing, as it allows the feed to be given with the minimum of attention. Artificial feeding, like breast-feeding, demands the close attention of the mother or nurse throughout the feeding. Many failures wrongly attributed to the contents of the bottle are in reality due to the want of skill of the person who handles it.

Further Details of Artificial Feeding. It matters little whether the feeds are made up as needed, or the whole day's ration made up in the morning. When dried milk is being used or where facilities for safe, cool storage of the milk mixture are wanting the former course is the better. By making up the whole day's mixture at one time inaccuracies in measuring the various ingredients will be minimized.

Absolute sterility of all vessels used for measuring and storing the mixture is important. This can best be achieved by boiling. Boiling water kills germs, but it is of course useless to place a vessel in boiling water and then dry it with a cloth which has been hanging in the nursery or kitchen, and thus been exposed to dust and flies. After the food has been prepared it must be protected from contamination by a suitable cover, and kept in a cool place until required for use. The baby's food must not be tasted. The rubber teats, like the bottles, must be scoured inside and out after use, then sterilized by boiling water, and stored in a covered vessel which has itself been sterilized.

Before being given to the infant the food must be at the right temperature, which is about 98·4° F. The importance of this point is often overlooked. During the feeding, which should last about twenty minutes, the food will tend to cool. This cooling can be minimized by covering the bottle with a flannel jacket. A pot of hot water should be at hand, and the bottle may be stood in this for about half a minute every three or four minutes to raise its temperature again.

Such pauses in the feeding are a help to the infant, who then has an opportunity of regurgitating any air he may have swallowed.

The ease with which the milk mixture flows from the teat is of some importance, and must be adjusted to the sucking powers of the individual baby. Some strong babies will suck so powerfully that the milk will flow from the bottle faster than they can swallow it, and choking results. Other babies are feeble suckers, though quite capable of swallowing the whole feed in twenty minutes, and a larger hole must be made in the teat in these cases. On the average a rate of one drop every two seconds, when the bottle is inverted, is found satisfactory, but no rule can be laid down. The hole is made in the teat with a red-hot needle. If a cold needle is used a valve-like opening usually results, which makes sucking very hard work, if not actually impossible.

MIXED FEEDING.

At the age of about six months food other than milk should be introduced into the diet of both artificially and breast-fed infants. This extra food may conveniently take the form of a cereal, such as oatmeal or barley. Small quantities should be given at first of the consistency of a thick gruel; this should always be given by spoon, as in this way the child learns early to take semi-solid food and, in the case of the breast-fed, a bottle need then never be used. At seven months green vegetables should be given as a purée. Care must be taken to avoid the inclusion of large and indigestible pieces. Green vegetables are a valuable source of iron, and this element is of great importance to the artificially fed. Seeded raisins also contain iron, and may well be given at about seven or eight months.

At eight or nine months the breast-fed baby should be weaned on to a mixture of milk and water, with added sugar. If mixed feeding has been introduced at six months the use of a feeding bottle should not be necessary; the child should take well from a cup and spoon. Weaning should be accomplished gradually, one breast-feed being replaced at a time, and a change made every week; in this way the process is spread over a period of four weeks, and the infant is given time to accustom himself to the change in diet. Opinions vary widely as to the strength of milk mixture to be given at this age. Generally speaking the infant who has been receiving starch in some form from the age of six months can be weaned to a stronger mixture than the infant who has had nothing but breast-milk. In any case, after weaning is accomplished the mixture should be gradually strengthened by the omission of water, so that its bulk is diminished as other foods are introduced.

At about eight months, or earlier if teeth appear, the child should be given baked crusts to chew.

At the age of nine months marrow-bone soup may be added to the green vegetables. At ten months milk puddings may be given, with the addition of cooked fruit, such as baked apple. From now on, the diet should be gradually modified until, at one year, the child is taking the bulk of his food at three meals, with a drink of milk at night.

FEEDING DURING THE SECOND YEAR.

Attention to the diet of the child during the second year is so important that it is surprising to find how frequently it is neglected, and the child allowed to 'take what is going.' At this stage of life habits are easily formed, and a habit of refusing food, often a gesture of self-protection, owing to the unsuitable nature of the fare provided, may easily lead to a state of chronic malnutrition. Second only in importance, then, to the choice of good and suitable food, is its preparation in an attractive and palatable form. Only in this way can the development of faddiness be avoided.

During the second year table manners must be inculcated. Children who are allowed to break off in the middle of a meal to play with toys, or who are pursued round the room by an anxious adult carrying the food and uttering entreaties, seldom take enough to satisfy their needs. Eating between meals should not be allowed. The child has a natural craving for sweets, and this should be satisfied, but at mealtimes; thus there is no reason why the midday meal should not conclude with a stick of barley-sugar or a boiled sweet.

Soft pappy food should be avoided as far as possible, and every meal should include some dish which needs chewing.

Dietaries for children are so numerous that it has been the present writer's object throughout to avoid details. The following diet-sheet

is included only so as to save much wearisome reading, and to serve as an outline, to be filled in and augmented according to individual ingenuity and culinary capability.

On waking 6–7 *a.m.*	Drink of orange juice and water. Later a raw apple.
Breakfast 8–9 *a.m.*	Baked toast with butter or dripping. Porridge or dried cereal. Stewed or pulped fresh fruit or baked apple. Milk to drink.
Dinner 12–1 *p.m.*	*First course.* Bone and vegetable soup or gravy, stiffened with breadcrumbs, potato, green or root vegetables; or lightly cooked egg, or white fish, or minced rabbit, or minced chicken, or brains, } with vegetables. *Second course.* Milk puddings, or custards, or junket with fruit and jelly. Light-steamed puddings with treacle or honey. Milk to drink. Piece of raw apple to end meal.
Tea-Supper 5–6 *p.m.*	Toast and butter, with treacle, honey, or jelly. Milk to drink, flavoured with chocolate or marmite. Cereals if still hungry.

A drink of milk may be given at 10 p.m. if the child is hungry, but this should be discontinued during the second year.

The above table, as has been said, is not supposed to be exhaustive; nor should all the foods mentioned therein be immediately introduced on the child attaining the age of one year. Their introduction should be spread over the second year, and new foods should be given in small quantities at first. Though all foods have to be minced at the age of one year, later they can be given in coarser form.

II—PROBLEMS OF SEX AND MARRIAGE

Puberty

In the first decade of life the differences between boys and girls do not as a rule prevent their competing on equal terms in physical and mental activities. Somewhere about the age of fourteen, however, puberty occurs; and from that time onwards there is observable a fundamental change in outlook which is usually accompanied by a divergence between the sexes in physical and mental capacities.

In boys, at about the age of fifteen or sixteen, marked changes begin to show themselves. Hair becomes noticeable on the face and the armpits and the pubes and, often, on the chest and other parts hitherto relatively hairless. The bones become markedly thicker and longer, and the muscles increasingly developed. The neck becomes thicker, and the nose longer. The voice 'breaks,' owing to the growth of the larynx. All these, and other, puberty developments are associated with the maturing of the male sex glands, the testes. It is well known that if, just before puberty, these glands are removed by the operation known as castration, none of these changes occur. Formerly castration was, indeed, frequently performed on youths in the Vatican choir in order to preserve the soprano quality of their voices. The physique of eunuchs employed in connection with Oriental harems further exemplifies the direct relation between the activities of the sex glands and the development of those physical and psychic characteristics that distinguish average man from average woman.

A parallel revolution occurs in the mind and body of the girl at puberty. Her hips become fuller, the breasts increase in size, and hair appears in the armpits and on the pubes. Menstruation—or the 'periods'—commences. Each month an ovum ripens and escapes from one or other of the ovaries, and passes along one of the Fallopian tubes into the womb. This escape of a ripened ovum, termed ovulation, is the fundamental physical fact of the woman's sexual life. Unless this ovum is fertilized by sexual congress, it escapes from the womb and is lost. Nearly a fortnight after ovulation, menstruation occurs; and this must be regarded as a 'missed pregnancy.' It will thus be seen that menstruation is a cycle usually determined by ovulation. If the period commences on a Monday, being the first day of the month, ovulation should occur about a fortnight later, and the next period on the fourth Monday, the twenty-eighth day of the month.

Although the periods are largely determined by ovulation the ovaries and ovulation are both under the control of the nervous and endocrine systems, and particularly of the front part of the pituitary gland.

Menstruation

In this country the periods usually begin at about the age of fourteen years, although they may first occur as early as nine or as late as twenty-four years. They should return at intervals of twenty-eight days, last for three to five days, and cause no pain. When they first start they are likely to be irregular, particularly if the girl is not previously warned about them, or if she is overworked at school. Although there should be no pain at the time of the monthlies, many girls do suffer pain which is sometimes very severe. The pain may be situated in the lower part of the abdomen, in the back, or to one side. The pain usually comes on just before the period commences, or during the first day of the flow, when clots may be passed—though these are not normal. In some girls the periods are very scanty; in others, they are very heavy and last for a week. It cannot be sufficiently stressed that the widest variations in this function are compatible with perfect health. If the pain is very severe or the loss heavy, a doctor should be consulted. The amount of iron in the body is extremely small; and if the girl loses too much at her periods she is apt to become anaemic.

Irregularities in the periods are due to two main factors: (*a*) Structural, (*b*) Mental. Very little need be said concerning the structural defects, except to say that the uterus or womb may be under-developed; and this and other similar errors are more easily corrected the earlier the girl consults the doctor. The effect of the mind and emotions on the periods is often very profound. It is, for instance, a very common experience for a young woman who leaves home and commences some form of work to miss her periods for several months, during which time she may put on a considerable amount of weight. Also, the periods may be stopped by a hot or cold bath, or by putting the feet into hot or cold water, if the girl is unaccustomed to bathing at these times. Then, too, a girl who suffers severe pain during menstruation may be relieved completely by a change in her circumstances, or by falling in love. There can be little doubt, therefore, that the mind may affect the rhythm, the flow, and the symptoms, associated with menstruation.

HYGIENE.

In the Pentateuch, strict instructions were given to women to segregate themselves and to consider themselves unclean during the periods. Indirectly, rest was enjoined. This custom, still observed to a certain

extent by Jews (and by many primitive peoples), may in some measure account for the extreme fertility of this race, and possibly for the fact that cancer of the womb is relatively uncommon in Jewesses. The extreme opposite view is favoured by many to-day. Women enter for athletic competitions, tennis championships, and even swimming races, whether or not they are menstruating. The fact that a considerable number of girls can perform extreme physical exertion during menstruation without apparent ill effects does not mean that they will not pay the price in later years. It is an interesting fact that the majority of women who run cross-country races or cycle a hundred miles during their periods will not dare to take a bath at that time, whereas others do not mind bathing but would not indulge in any violent exercise. From the medical point of view there is no valid reason why a girl should not have a warm bath and live a normal life during her periods; although prudence suggests that severe physical exercise should be avoided. She should take a tepid bath each morning of her life, rub herself briskly with a rough towel, and then spend five minutes doing simple Swedish exercises. She should sleep on a relatively hard bed, with her windows wide open, and not go out to too many dances or visit the cinema too frequently. Trouble during menstruation is frequently due to late nights and insufficient sleep. This is particularly true of girls who have to earn their living, although it applies also to those who spend their energies trying to make life worth living. If the 'losses' are heavy it is wise to take periodic courses of iron. The best preparation to take is Blaud's pills, which can be obtained from any chemist. Two may be taken after each meal for three months. Iron, however, tends to cause constipation, and it may be necessary to take senna tea during the course. The vast majority of women, whether or not they suffer pain, are not able to concentrate so effectively or to engage in active mental pursuits so successfully during menstruation as at other times.

Marriage

There are three main reasons why people marry: (1) Because they fall in love; (2) For convenience; (3) Because of physical sexual attraction. Of these three reasons, the last is by far the least satisfactory. True love is compounded of many ingredients which include physical attraction, but it is hallowed by spiritual affinities. Happy marriages may occur between individuals who have intellectually little in common, but rarely if they are divided by religion or colour. Marriage is a complementary blending, and can only be truly successful when both parties obey the Christian precept, 'By love serve one another.' The third reason for marriage is unsatisfactory just because both husband and wife marry for what they can get and not what they can give.

Sexual attraction tends to decrease with its 'satisfaction,' which can occupy but a small fraction of time; and, unless it is replaced or supported by friendship, attraction may turn into loathing and hatred. Further, the man or woman who marries for sex satisfaction is likely, after a while, to be attracted more powerfully by another individual. It cannot be too strongly emphasized that sexual passion tends almost invariably to decrease with its gratification. Marriages of convenience, on the other hand, are often moderately successful on a low aesthetic plane. Neither partner expects too much from the other. The marriage settlement unites two neighbouring farms, or results in mutual advantages to both partners, and it pays to make the marriage a going concern. Marriage, in this country, is on the whole a very harmonious institution; for, while the number of really ideal unions 'made in heaven' may be small, the vast majority are tolerably harmonious. The failures of the marriages of 'bright young things,' which never possibly could have been successful, are advertised in the divorce courts; while the incomparably greater number of truly happy marriages are only known to the limited circles of friends. Laziness and selfishness wreck more homes than do any other faults. It is more important for a man to know what a girl is like at breakfast; what is her attitude to children, and what their reaction to her; how she treats the old and infirm; and what is her ability to cook and housekeep, than to be carried away by the success she creates at a ball, or the degree she obtains at a university.

PHYSICAL FACTORS.

There are people who urge that both partners should be medically examined and present each other with a medical certificate before they are married. There is much to be said in favour of this view, although there are not a few obvious objections.

In the first place, through the fault of one or both partners, the marriage may be incapable of being consummated. The woman may be imperfectly formed, the entrance to the vagina may be blocked by a membrane, or the entrance may be narrow and the pain of coitus so great that the act may not be allowed. Most of these difficulties may be removed by medical attention. The male partner, on the other hand, may be incapable, for physical or psychological reasons, of consummating the marriage. If it be proved that sexual congress cannot occur, the State is willing to cancel the marriage, and even the ecclesiastical authorities regard the marriage as null and void.

In the second place, one or other of the partners may be suffering from one of the venereal diseases; the other partner may catch it, and endure suffering for years. Of a man or woman, who, knowing himself or herself to be suffering either from syphilis or from gonorrhoea, marries

without divulging the fact, it is impossible to speak too harshly. The trouble about the venereal diseases is that it is very difficult to know when they are cured. An individual may honestly believe himself to be perfectly free from disease, and yet convey it to his bride. From both the medical and the sociological points of view, the examination of both partners by an experienced physician would be of inestimable value in preventing individuals with venereal disease from causing tragedy in a new home. It is, however, obvious that until recently the vast majority of girls have not even known of the existence of these diseases, and it would be difficult to persuade public opinion to regard such a development with favour. Whether or not it ever becomes the law of the land that partners shall produce medical certificates before marriage can be solemnized, it would be well for parents to insist on such certificates being produced before they consent to their daughter's marriage if they have any suspicions that the sexual life of her prospective partner has ever been irregular.

There are a number of other physical and psychical conditions which would render an individual unsuitable as a mate. In the first place hereditary conditions must be considered. Certain types of mental disease are very likely to be hereditary, and may possibly skip one generation and appear in the next. It is always a risky procedure to marry an individual who has more than one direct relation in an asylum. There is, for instance, a disease called Huntington's chorea, now more common in America than in this country. A thousand persons with this terrible disease were studied and it was found that they were all descendants of about six individuals, three being brothers, who migrated to America in the seventeenth century. Besides mental diseases and certain forms of paralysis there is no doubt that excessive alcoholism damages the germ plasm and that this damaged plasm is hereditary. Chronic and severe alcoholism in a family may make the children undesirable partners in marriage. Only one other form of hereditary disease will be mentioned. Haemophilia is a disease which occurs only in males, who are called 'bleeders.' A scratch or the extraction of a tooth may result in a fatal bleeding. This disease, although it only occurs in males, is transmitted only through the female, and thus skips a generation. Some or all of the male children of a woman who is the daughter of a 'bleeder' will probably be 'bleeders.'

Finally, there are a few general medical conditions which make a man or woman undesirable as a mate. Epilepsy and gross heart disease obviously render a woman unsuitable to become a mother, while chronic kidney disease, which may remain undetected, is a serious complication of pregnancy.

But prudence can be overdone. Some eugenic enthusiasts would, if they had the power, arrange marriage on a card-index system; but

men and women are not cattle; and the intellectual, as distinct from the physical, quality of the offspring appears to run independently of any known laws.

STERILITY.

Sexual congress may at first be attended with minor difficulties. The entrance to the vagina may be small, and the defloration or breaking of the maidenhead may be attended with pain or bleeding. Occasionally, though rarely, the bleeding is so severe as to require medical attention. The act, in its highest form the sublimation of the love of a man for a maid, has—or should have—spiritual as well as physical qualities. Few married people can safely enjoy coitus more than twice a week; and for many once a week may be too often. After the act, the partners should fall asleep; subsequent wakefulness is a sure sign that it has been improperly or unsatisfactorily performed. Mental or physical fatigue the next morning is a definite indication that sexual congress is occurring too frequently. On the other hand, more unpleasant symptoms may occur if two individuals sleep together and, for any reason, refrain indefinitely from sexual intercourse.

One of the purposes of marriage is that the union may be fruitful. About one out of every fifteen marriages remains barren. In some cases the woman, in others the man, is at fault; but in the majority of cases the 'blame' must be apportioned between the two partners. It has been shown in a previous chapter that the biological reason for sexual intercourse is the necessity for the transference of protoplasm from the male to the ovum. Either the spermatozoon or the ovum may be unhealthy, or the sexual act may be improperly performed. The Fallopian tubes may be blocked, or other mechanical factors may prevent the spermatozoon from reaching the ovum. In some cases nothing can be done to remedy matters. In others, expert medical attention may render a barren marriage fertile. Although it is not excessively rare for a couple to have their first child after being barren for fifteen to twenty years, it is advisable for married people to consult expert medical opinion if at the end of two years after the marriage pregnancy has not occurred. Coitus is likely to be most fruitful when performed between the tenth and fourteenth days after the commencement of the menstrual period.

Pregnancy

DIAGNOSIS.

If a healthy married woman whose courses are regular misses a period, the probability is that she is pregnant. Occasionally, scanty periods may occur during the first three months of pregnancy and upset

all calculations. The duration of pregnancy is ten lunar months, and the date of the expected confinement may be calculated by adding twelve days to the date of the commencement of the last period, and counting back three calendar months. If, for example, the last period commenced on the 1st April the confinement may be expected on the 13th January. It is important that married women should note each month the dates of their monthlies, otherwise it may be extremely difficult to know when baby is to be expected.

There are two symptoms often associated with early pregnancy. One is a frequent desire to pass urine, and the other the occurrence of shooting pains in the breasts. At the end of the sixth week of pregnancy sickness often occurs, and lasts for six weeks to two months. The sickness is generally felt when the woman gets up in the morning. If she stays in bed, and takes a cup of tea and some dry toast, the nausea passes away, and does not recur until the next morning. In some cases, however, the sickness comes on at night when the patient goes to bed. More rarely, spells of nausea occur at intervals through the day. In the worst cases the patient cannot even keep water down, but vomits almost continuously.

Some authorities regard morning sickness as neurotic—or due to 'nerves.' Inasmuch as over 50% of all pregnant women, the world over, suffer from this troublesome symptom, it may be assumed that this explanation does not represent the whole truth.

A doctor is usually in the position, as the result of an internal examination, to say whether or not a patient is pregnant. There is now a test for pregnancy—called the Ascheim-Zondek test—which is remarkably accurate. After the fourteenth week of pregnancy the X-rays show the foetus. Indeed, the X-ray picture offers the earliest absolute evidence of pregnancy.

NORMAL PREGNANCY.

When once the woman recovers from morning sickness she should enjoy perfect health, and many women never feel so well as towards the end of pregnancy. The only disadvantage is the gradually increasing size of the womb, which makes locomotion difficult, and interferes with the breathing and often with the digestion.

At the end of the twenty-sixth week the top of the womb is level with the navel. The level at this date affords the only accurate physical means of estimating the date of the confinement. By the end of the thirty-sixth week it reaches to the bottom of the breastbone. At this stage it pushes up the diaphragm, displaces the heart, and interferes with the breathing. Further, the movements of the child are sometimes tumultuous, and disturb the sleep. At the end of the thirty-sixth week the head ought to enter the pelvis, thus allowing the womb to fall

downwards and forwards. This change makes breathing and walking much easier, but increases the frequency of the desire to pass water. The general health of the woman ought then to be excellent, the sole disadvantages being due to the bulk of the pregnant uterus.

CLOTHES.

The pregnant woman should avoid wearing corsets or any supporting band. If, however, especially towards the end of the day, the weight becomes intolerable, support and relief may be obtained by an obstetric belt. Elaborate and costly belts may be purchased, but equally satisfactory results are obtained from a belt made of ordinary towelling. The whole secret is to secure support for the lower part of the abdomen. On no account should garters be worn, as varicose veins are apt to appear during pregnancy. Garters, by compressing the skin veins, increase this tendency.

EXERCISE.

The pregnant woman may take any exercise to which she is accustomed, so long as she does not become unduly fatigued by it. Walking, swimming, cycling are all permissible, but hunting, violent tennis, or serious golf, are inadvisable. Abortion or miscarriage may follow any violent or sudden strain, particularly during the early months of pregnancy. There is, moreover, a well-founded belief that miscarriage is more likely to take place at those times when the periods would have occurred if the patient were not pregnant.

DIET.

The diet during pregnancy is of the utmost importance. The foetus requires a large amount of various substances, of which the mother has not too large a store. Assuming the woman is perfectly healthy when she becomes pregnant, she should take the ordinary diet to which she is accustomed. Towards the end of pregnancy, meat should be taken not more often than once in the day; although fish, particularly herrings, may be taken as often as desired. Plenty of fruit, especially oranges, and of salad and vegetables of all kinds, should be included in the dietary. The woman should drink at least a pint, preferably two pints, of milk each day, and take plenty of eggs and cheese. A teaspoonful of marmite, a dessertspoonful of a good brand of cod-liver oil, and two glasses of water between meals, would make the diet complete. If she is anaemic at the beginning of pregnancy she should take two Blaud's pills half an hour after each meal.

BOWELS.

Many women suffer from constipation when they are pregnant. There are two golden rules to be observed if this distressing complaint

is to be avoided: (1) To seek relief with regularity; (2) To drink plenty of water. The stomach is in nervous communication with the beginning of the large bowel. The breakfast entering the stomach after the night's fast sets up a desire, some half-hour later, to go to stool. If this summons is neglected the desire and the ability to empty the bowels pass away, and the opportunity is lost. Secondly, water is absorbed from the large bowel so that the motion becomes hard and difficult to pass. It is for this reason that it is desirable to drink two or three glasses of water a day, between meals. In order to correct a long-standing misuse of the bowels, it may be necessary to take medicine for a few weeks; although this may often be avoided by suitable exercises or massage. Liquid paraffin and senna tea are two drugs relatively safe to take for this purpose. Liquid paraffin acts by lubricating the bowel. Take two tablespoonsful of oil morning and evening for one week. Then leave out the morning dose. At the end of the second week one tablespoonful at night should suffice. There is one warning to give. The oil may leak from the bowel unexpectedly, and it is therefore advisable to wear a pad for the first fortnight. Should the paraffin for any reason be unsuitable, senna tea may be used. Buy some senna pods, and keep them in an airtight tin. Take ten pods, let them stand in a half-tumbler of cold water all day, and drink the tea before retiring. Increase or decrease the number of pods as necessary. The milder saline aperients, taken in plenty of water, are favoured by some. They are relatively harmless. It should be borne in mind that the idea is to recover the normal bowel routine, and all drugs should be discarded as soon as possible. If a woman is regular before she becomes pregnant, she will not have to use any drug during the first half of her pregnancy. Even later, half a lemon squeezed into a cup of cold water, unsweetened, and drunk during the night, may avoid the necessity for any drug. It is impossible for any individual to enjoy good health if constipated; but during pregnancy constipation may be a source of real danger.

URINE.

The bowels get rid of unwanted food, the kidneys excrete the waste matter resulting from bodily activities. The vast majority of women never have their water tested until they become pregnant. It thus happens that many with Bright's disease or chronic inflammation of the kidneys become pregnant without knowing that their kidneys are not normal. Then, too, pregnancy in a certain number of cases is associated with kidney trouble, not previously existent. It is therefore desirable for every woman, so soon as she knows she is pregnant, to consult her family physician or midwife, or to attend the ante-natal clinic of a well-run maternity hospital. She should take notice of

the amount of water she passes each day. If, towards the end of pregnancy, there is a serious falling off in the amount, the condition calls for immediate medical care.

MINOR AILMENTS OF PREGNANCY.

Teeth and Gums. The gums may become swollen, have a strawberry-like appearance, and bleed easily. The teeth may give trouble, or one or more become decayed. If the teeth are sound at the commencement of pregnancy they may be preserved if plenty of calcium (or lime salts) is taken in the diet. If two pints of milk and a dessertspoonful of a good brand of cod-liver oil are taken each day, there will be no need to worry about teeth.

Hair. Not infrequently, during pregnancy, the hair loses its glossiness and tends to become brittle and fall out. Similarly, the finger nails may become brittle and tender. Milk and cod-liver oil will prevent trouble with the hair and finger nails.

Haemorrhoids or Piles. This troublesome condition if normally present tends to become worse during pregnancy. The essential thing is to avoid constipation and straining at stool. No surgical interference can be considered until the child is born, but much relief may be obtained by medical treatment.

Swelling of the Feet. Anybody who stands on his feet long enough will get swelling of the feet. The bulk of the pregnant womb presses on the veins of the legs and often causes swelling of the feet which, however, normally disappears after a night's rest. If the swelling persists, and especially if it occurs also in the upper part of the legs, the arms, or the face, medical attention must be obtained.

Varicose Veins. If a woman is normally troubled with varicose veins they will get much worse during pregnancy. Sometimes they first appear during pregnancy. Valuable support may be obtained from elastic bandages applied in the morning before getting out of bed. The expectant mother, so suffering, should recline for a good part of every day, and should when sitting make a point of resting her feet on a chair which is higher than the one she occupies. Occasionally the veins become enormous, and affect the private parts. If at all possible such a patient should stay in bed until the child is born. Should any of the veins burst the bleeding may be very alarming. In such event take two clean handkerchiefs, press firmly on both sides of the bleeding point, and maintain the pressure until the doctor arrives. After the baby is born the question will arise as to whether it is expedient to have the veins injected or removed.

Indigestion and Water Brash. As the womb increases in size it leaves less room for the stomach to expand when food is eaten. Therefore women, towards the end of pregnancy, frequently suffer from indi-

gestion, with regurgitation of fluid into the mouth. It is important that the bowels be kept well opened and that no heavy meal be taken at night. Indeed, heavy meals should at any time of day be avoided. A teaspoonful of sodium bicarbonate in a little water taken shortly after food sometimes relieves the discomfort of this sort of indigestion. The juice of half a lemon in a half-cup of water taken at night, and unsweetened, is helpful.

Cramps. Towards the end of pregnancy troublesome cramps may occur in the calves of the legs or in the thigh muscles. They usually occur at night, and cause the patient to get out of bed and walk round the floor. Besides being extremely painful, they affect the general health by disturbing the sleep. If cod-liver oil and two glasses of milk are taken daily from the beginning of pregnancy, cramps will rarely occur. They may, if necessary, be successfully treated by an injection of calcium.

Itching. Occasionally itching, which may be general or localized in the private parts, proves a distressing symptom. The urine should be tested to see whether it contains sugar, and the limitation of this substance in the diet may clear up the symptom. The localized form is frequently due to excessive moisture and discharge from the vagina. The parts should be washed with warm water, and carefully dried with a soft towel every time a visit is paid to the lavatory. The parts should then either be dusted with ordinary talcum powder or lubricated with cream. Sitz baths of weak potassium permanganate may prove helpful. Douching should not be carried out except under the orders of a doctor. The generalized form, which is not associated with sugar in the urine, is probably due to some defect in the diet, and consequently does not respond to ointments. It is unlikely that a woman who, during the whole of her pregnancy, takes the diet already suggested, will ever be troubled with this complaint.

High Blood-pressure. The blood-pressure is not usually significantly affected by pregnancy. Occasionally it may be lower than normal, but more often it becomes raised. This increase in the blood-pressure is important to detect, as it may be associated with albumen in the urine. In this case the patient should place herself under medical control.

It will be seen from the short description given above that a small percentage of pregnant women are liable to suffer from certain unpleasant disturbances, some of which (e.g. varicose veins, haemorrhoids, swelling of the feet) are due to mechanical factors, others to dietetic deficiences (e.g. trouble with the teeth, hair and nails, cramps, etc.), and yet others to pregnancy toxaemia.

Any or all of the following symptoms should cause the woman to visit the doctor, or the hospital, without delay: (*a*) headache; (*b*) dimness of vision or sudden blindness; (*c*) severe pains in the upper part

of the abdomen; (*d*) marked swelling of the face, arms, and legs; (*e*) a sudden or noticeable decrease in the amount of urine secreted.

A toxaemia of pregnancy requires expert treatment, preferably in hospital. There is no general agreement as to the cause of this strange 'disease,' but the majority of doctors believe that it is somehow bound up with the diet. It is certain that it may be generally avoided by taking the diet already described, and by avoiding constipation.

Haemorrhage. Any bleeding during pregnancy, however slight, is abnormal, and should lead the expectant mother to have a thorough medical examination without delay. In the early months, such bleeding may denote a threatened miscarriage. In the later months, it indicates the possibility that the after-birth is in part situated below the head of the baby. The condition may present extreme difficulties. It may be necessary to remain in bed under the closest observation for several weeks.

Vaginal Discharge. Many women suffer from a whitish vaginal discharge, which increases during menstruation. It also often increases considerably during pregnancy. It should be known that the discharge may be due to gonorrhoea, and consequently a source of danger to the eyes of the baby as it is being born. Some doctors are of the opinion that a heavy vaginal discharge makes a woman more likely to suffer from puerperal infection or child-bed fever, but there is little evidence to support this supposition. Much may be done to decrease the amount of the discharge by medical treatment.

Childbirth

Labour is a physiological process and can be completed in 90 per cent of all cases without any medical aid. On the other hand some cases require the most expert skill if disaster is to be avoided. The essence of the problem of childbirth is summed up in these two sentences. There is universal agreement that child-birth is safer both for the mother and the child if it is quite spontaneous. The art and skill necessary to know which case can be left to the natural efforts of the mother can only be acquired after long and tedious apprenticeship. The modern tendency is needlessly to use operative procedures, which save time and anxiety, but which often result in loss of life.

During recent years the public has been made aware of the serious mortality associated with child-birth. Various commissions have been set to work, and have contributed their reports, but the net result would appear to be the fostering of a state of alarm amongst the people without the slightest improvement in results. The facts of the situation are relatively simple. From four to five women out of every thousand who give birth to living children in England and Wales each year die

as the result of child-birth. So far as can be ascertained the figures are little or no better than they were at the end of last century.

These deaths may be divided into three main categories: (1) toxaemias; (2) accidents; (3) puerperal infection—or child-bed fever. Whereas the toxaemias first occur towards the end of pregnancy, and usually offer time for their consideration and treatment, the accidents and infection occur at the time of delivery. They not only require great skill in treatment, but unlimited time. For instance, a common cause in both groups of deaths is a mild degree of contracted pelvis. The bones of the mother's pelvis are smaller than normal, and the question is whether the baby's head can go through. It is relatively very simple to perform Caesarean section (or to deliver the baby through a cut in the mother's abdomen), though this operation has its dangers. It is very tedious and requires much skill and judgment to wait and watch the progress of labour. If the child can be born spontaneously it is much safer for the mother, but the obstetrician may have to spend hours in careful watching to know exactly when to interfere.

The best solution of the problem would be to encourage 90% of the patients to be delivered by midwives, and to make provision for the remainder to be attended by skilled obstetricians. At present over 50% of all women are delivered by midwives alone. A large number are attended by the family doctor, and only a relatively small number by really skilled obstetricians. The great advantage of delivery by the midwife is that she is not allowed to carry out any operative procedure, and is content to wait for the normal course of events to occur. Although the training and organization of midwives in this country leave much to be desired, the majority are able to conduct normal cases with safety. When the midwife gets into difficulties she sends for the family physician or some general practitioner. Many of these family doctors become expert obstetricians, but the fact remains that the medical student frequently conducts fewer than ten confinements before he becomes qualified. Moreover, patience is the essence of good midwifery; and it is impossible for the busy and successful practitioner to afford the necessary time without neglecting other needy patients. The result is that instrumental interference is often applied unnecessarily, to the greatly increased risk of both the patient and her child.

A careful consideration of these arguments leads one to the conclusion that the best way in the interests of all parties would be to build a number of large maternity hospitals, each responsible for, say, two thousand patients a year. Such hospitals would provide enough work to occupy the time of expert obstetricians, who would be able to train disciples. Small maternity hospitals are relatively dangerous, and the institution which is not large enough to demand a resident

specialist obstetrician should be pulled down. It is infinitely safer for a difficult case of midwifery to travel fifteen miles in an ambulance to reach an expert than to travel two miles to reach a poorly skilled obstetrician. If the midwife is in difficulty she ought to be in a position to summon an ambulance and send the patient to the nearest maternity hospital. The main arguments may be summarized as follows:

(1) Normal, spontaneous labour is infinitely the safest method of delivery, and all operative procedures are fraught with risks.

(2) The proportion of abnormal cases is so small that the possible number of expert obstetricians must remain strictly limited.

(3) An individual can only become an expert obstetrician through serving at least three years' apprenticeship in a large maternity hospital.

(4) All maternity hospitals must be large, in order to occupy the whole energies of specialists, and permit of their training disciples.

(5) Modern transport is such that a very small number of large well-equipped hospitals could serve the whole of England and Wales. All small maternity departments and small maternity hospitals should be abolished.

ANTE-NATAL CARE.

This subject has been left to be considered separately. Ante-natal care is a modern development, and was originally instituted for the benefit of the unborn child, and not for the expectant mother. All the stress to-day is laid on the care of the pregnant woman. If properly carried out, ante-natal care should be a tremendous advantage in the practice of obstetrics. In the first place, it permits the discovery of all women suffering from heart and other diseases who ought never to have become pregnant. Then it allows the kidney functions and the blood-pressure to be investigated. When adequately carried out, it ought to be possible to detect cases which would, without treatment, end in labour convulsions and Bright's disease. Lastly, it is possible to segregate those women with small pelves, and send them for expert investigation.

Ante-natal care, while being thus potentially beneficient, is, in fact, fraught with many dangers. If ante-natal care were left to conservative and skilled obstetricians, it would be among the most beneficent developments of the century; but, as this is not the case, it has undoubtedly led to an enormous amount of meddlesome operative interference.

LABOUR.

By labour is meant the process by which the child is born into the world. It is divided into three parts: (*a*) the stretching of the mouth of the womb to allow the child to pass through; (*b*) the passage of the child through the pelvis into the world; (*c*) the delivery of the after-

birth. The whole of labour normally requires between a hundred and a hundred and fifty 'pains,' and occupies about eighteen hours in the case of a first child. Labour 'pains' may not be painful, and many women deliver themselves of their first-born without suffering any pain. There is not the slightest doubt that fear, conscious or unconscious, increases the severity and decreases the efficiency of the pains. For this reason it is a great pity that mothers and midwives so often put fear into the heart of the young woman who is shortly to become a mother. It is regrettable also that benevolent people have stressed the pain of child-birth in their well-intentioned but misguided efforts to secure the widest use of anaesthesia during child-birth. There is no anaesthetic which is absolutely safe. Even if the yearly six hundred thousand expectant mothers in England and Wales were given anaesthesia by the most skilled anaesthetists, there would be an appreciable mortality from the anaesthetic alone. It is not practicable for all these women to secure the services of skilled anaesthetists, so that in practice the dangers of anaesthesia would be much greater.

The pains during child-birth usually occur at intervals of from five to ten minutes. Shortly after the child is born, the woman is perfectly 'well,' and would appear normal to any visitor. The pains of normal labour take no serious toll of the woman, and usually the joy of the birth of a child more than outweighs any suffering she has had to endure. Every doctor would be more than willing to make all labour painless provided it could be done with safety. Clear-thinking obstetricians, however, are not willing to risk life for the sake of alleviating bearable pain.

The two safest places in which a woman can be confined are: (*a*) a large, efficient maternity hospital; (*b*) her own home. There can be no doubt that for people of moderate means the hospital offers many advantages. If the confinement is to take place at home the room in which it is to occur should be reasonably near the bathroom and lavatory, and not far from the kitchen or some place whence an unlimited supply of hot water can be obtained. It should be as bare of furniture as possible, and should contain one single bed, both sides of which are placed well away from the walls. Boards should be available ready to be placed under the mattress to prevent it from sagging during the actual delivery.

AFTER DELIVERY.

When the after-birth has come away, the patient should be put comfortably to bed, and given a cup of hot tea. She is likely to be tired, and may shiver after her efforts. Within a few hours she is likely to be quite well, and to differ from a normal woman only in two ways: (*a*) Her womb is very bulky, and will take time to return to its

proper size; (*b*) The place in the womb to which the after-birth was attached is a wound, and is liable to become infected.

In days gone by, large and uncomfortable binders were fastened round the abdomen shortly after delivery for the sake of the figure. The patient was, moreover, kept flat on her back for several weeks. The modern obstetrician has no use for binders, mainly because they prevent the patient from sitting upright and moving about in bed. Sitting up, if necessary with the feet over the side of the bed, promotes drainage from the uterus, and so helps to prevent infection. The best method of helping the figure to return to the normal is by exercises.

If a woman is healthy and strong, she can get up almost as early as she likes. Most women, however, need a rest from household duties, and it is as well for them to stop in bed for at least ten days.

When the baby is born the mother's breasts contain a fluid called colostrum; but the flow of milk is not usually established until the third day. It is interesting to note that colostrum is very much more concentrated than milk, and is said to contain a mild laxative. The baby should be put to the breast at six-hourly intervals by day until the milk arrives, and thereafter either three-hourly or four-hourly. If the baby weighs seven pounds or over, it is well to start him on four-hourly feeds, as it involves less strain on the mother and is better for the child.

Under no circumstances should the baby be fed at night. His little stomach needs a rest, and so also does his mother. It is usually possible, by the end of the first week, to train a baby to sleep through the night. If he cries by night he may be given some warm water without any sugar out of a bottle. During hot weather water should be given between feeds. Seeing that milk is rich in calcium and fats, it is well that the nursing mother should take at least two pints of milk a day, plenty of gruel, and at least a dessertspoonful of cod-liver oil.

CARE OF THE BREASTS.

The care of the breasts should commence early in pregnancy. The nipples should be carefully cleaned each day and gently pulled out. After the nipples are carefully dried a little spirit should be applied to harden the skin. Immediately before and after each feed the nipples should be cleansed with either plain water or a weak boracic solution. Some people paint the nipples with a mixture of glycerine and borax. Care of the breasts is important, because suckling causes moist friction, which tends to damage the skin of the nipples. Through these cracks infection may travel into the breast, causing inflammation and sometimes a breast abscess. Any milk left on the nipples easily ferments, and forms ideal food for bacteria. After the nipples are cleansed subsequent to nursing the baby, the breasts should be covered with a clean towel, so that the nipples do not come into contact with the clothes.

The womb should return to normality in about six weeks, when the lying-in period terminates. At this time it is advisable for the mother to be examined, to make sure that the womb has returned to its normal size and position, and to discover whether any damage has been done to the supports of the womb or the bladder.

THE BABY.

As soon as the cord is tied and cut, the infant should be wrapped in a warm blanket and kept in a safe place until the mother is comfortably settled. Before the baby is bathed he should be thoroughly examined to make sure that he is perfectly formed, and that the bowel opens properly on to the surface. It is also important to see whether the palate is normal. Frequently a cleft palate is not discovered for several days. A drop of 1% solution of silver nitrate should be instilled into each of the baby's eyes in case infection occurred during delivery. The cord should not be allowed to get wet in the bath, and should be dressed with powder and a piece of sterile lint kept in place with a small binder. The baby should be held over a basin or chamber-pot before being bathed. It is surprising how soon a baby can be trained to be clean.

A healthy baby should sleep most of the day and night, and simply wake up to feed. He cries: (*a*) because he is hungry; (*b*) because he is thirsty; (*c*) because a pin is sticking into him, or he is wet and uncomfortable; or (*d*) because he is 'naughty.' The last should never be assumed until all other explanations have been excluded.

The baby should be warmly but lightly clad, and the clothes should allow full freedom of movement. He should be put out in the fresh air as soon and for as long as possible. The dark brownish-black stools should have stopped by the fourth day. If not, a good big teaspoonful of castor oil should be given. Subsequently, the motions should be passed three or four times daily, be slightly formed, and of a canary-yellow colour. Any change in the stools is an indication that all is not well with baby. When at the breast the infant should be made to feed, and not be allowed to fall asleep or to swallow air. The stools and the scales afford the best criteria of the infant's condition.

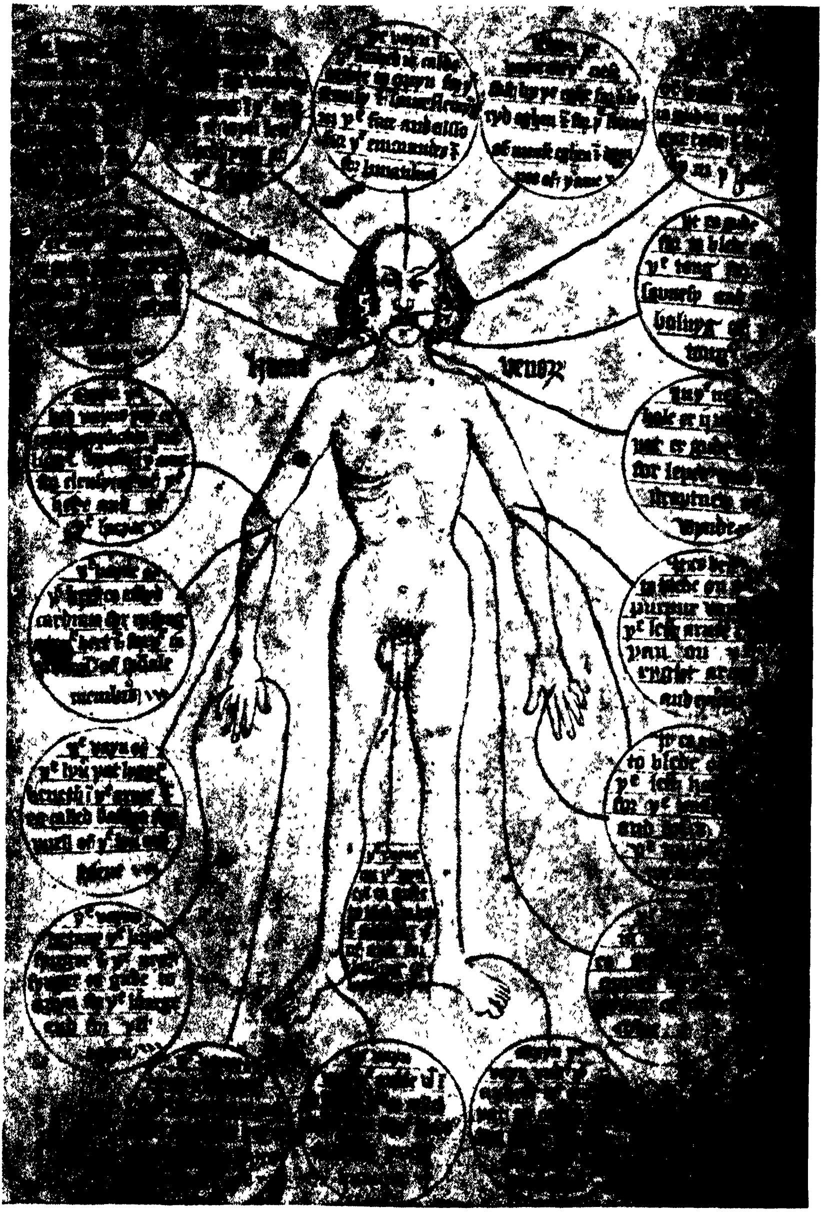
III—PARENTHOOD

Having a Child

THAT many people enter into marriage with but the vaguest idea of the problems and perplexities that they will meet is now a commonplace with which we are all familiar; but the position of those who become parents is less often held in question. Failure in the parental relationship, although it may have much more far-reaching effects than in the case of marriage, does not so often lead to legal action and public scandal, and thus the results are apt to pass with less notice. Nevertheless, it is through bad parentship that a great many of the evils of existence are handed from one generation to the next, and through good parentship, more than through anything else, that the foundations of happiness are laid.

When we think of the amount of training and education that is given to making us able civil servants, proficient bridge-players, or even tolerably attractive companions, it is strange that so little is done to assure our success as parents. Indeed parenthood—motherhood especially—is still largely looked upon as a province where Nature will teach all that needs to be known; and the sacredness of the maternal instinct remains something not to be tampered with lightly. Yet we know that, where other instincts are concerned, behaviour has to be modified by experience, by intelligent learning and thought, if they are to function successfully. So is it in parenthood. There is a great deal to learn, only unfortunately the need to learn it often only becomes apparent at a rather late stage in the proceedings.

When two people have a child, it is an event—to them—of extraordinary importance. They find themselves swept by emotions of unexpected power, just as the boy and girl at puberty or the man and woman first falling in love find in themselves feelings and impulses quite new to them. With the wife's pregnancy, and more still with the birth of the child, new instincts and emotions are aroused. Yet it is by no means true that a parental instinct makes its first appearance at this time. A strongly emotional attitude towards children and towards *having a child* has existed and has developed from very early years indeed, so that the parents, when their child is born, receive it in a way that is determined to quite a surprising extent by the past history of their own childhood and youth. The predominant feelings will be the pleasur-



By courtesy of the Trustees of the British Museum

DIAGRAM SHOWING THE CORRECT PLACES FROM WHICH TO BLEED, UNDER THE DIRECTION OF HEAVENLY BODIES, ACCORDING TO THE DISEASE

From the Guild Book of the Barker Surgeons of York

able ones of love and protectiveness, but more disturbing elements are likely to enter as well. For their own past has usually not been entirely smooth. They had perhaps, in their early years, to adapt themselves to the arrival of younger brothers and sisters. They have seen that the new baby, which was a thing to love and protect, was also something which drew upon their parents' attention and was a serious rival in the home. The love for it was not unmixed with jealousy. It is not difficult to find traces of this attitude persisting into adult life. The husband who does not feel somewhat out of it when his child is born is probably the exception rather than the rule. In some cases he may even feel so much out of it that his love for his wife and for his child is not strong enough to meet his distress, and the marriage suffers in consequence. The wife is far less likely to feel the child as a rival in the beginning, although this may happen later on. Yet her attitude may not be one of unmixed joy. In her own early years she will have had to cope with the desire to have and possess a child herself, a desire which is so strong in small girls. This may perhaps have led her always to take an interest in children, at first through play with dolls and care for her smaller playmates, and later by work where children are concerned. In this case it will have helped her very much in dealing with her own child. The desire may, on the other hand, have been so imperious and so discomforting that it was pushed aside altogether. Children were something that always belonged to her mother and not to her, so it was best to forget about them. She may thus have chosen a life in which she came very little into contact with them and appeared on the surface to be indifferent to them. Having a child herself will then change rather violently her former position and may lead to quite a number of difficulties. A very common way in which this rather *mixed* attitude towards the child shows itself is in over-fearfulness for his welfare. The mother is always anxious lest something dreadful should happen to him, and she worries at the least trifle. Her lack of confidence is not only a burden to herself but makes it difficult for the child to grow up freely and normally. Since her way of life has kept her largely away from children, inexperience and lack of knowledge in the practical handling of the child add to her problems.

These are only two of the many ways in which difficulties may become apparent with parenthood. For the most part, as is obvious, jealousies and antagonisms, fearfulness and anxiety, are far outweighed by the real love for the child. But this does not mean that we should shut our eyes to these negative aspects. Rather we should be prepared to recognize and face them if they appear, and should make sure that we have the means to control them.

Some things that help in such control are obvious. In the first

place the parents themselves must be happily married in the full sense of the word, finding adequate satisfaction for all their varying emotional needs in one another. Otherwise their attitude towards the child is almost sure to be an imperfect one. Quarrelling and estrangement may come, which are unquestionably harmful to him and exaggerate the less favourable aspects of the parental relationship. The tendency may develop to call upon the child for that affection and understanding which the husband or wife fails to supply. A bond may be established which sets a great strain upon him and makes difficult his progress into the world beyond the family. Both for the child's sake and for that of the parents, happy marriage is of the first importance. The notion that having a child may mend an unhappy marriage is a very dangerous one. In a few cases perhaps it may work, but in many others it will have the opposite effect; and the child will pay for the parents' experiment.

The parents' love for and confidence in each other as individuals must go hand in hand with confidence in each other as parents. It is not necessarily quite the same thing. A man may have the greatest faith in his wife's ability as, say, a novelist; but unless he also trusts her as a mother, they will bring up their children with difficulty. As an extreme of this lack of confidence we see the father who feels compelled to keep in touch with every detail of nursery management and still is not satisfied that things are being properly done; or the mother who, much as she loves and admires her husband, feels him to have so little understanding of children that she keeps them and their affairs to herself and leaves him very much a stranger to his own family. The co-operation of both parents is needed for the best upbringing of the children, and unless each trusts the other as a parent the stable and consistent environment which the child needs will rarely be produced.

Another way, of a practical kind, in which the difficulties of parenthood in the early stages may sometimes be diminished, especially where the mother is concerned, is through previous experience in handling children. Quite often nowadays one may hear the remark: 'You know, I never bathed a baby in my life until my own child was born.' This position, which arises fairly commonly under modern conditions, does not make the task of the young mother simple. We would suggest that every woman, before she has her first child, should find opportunities of dealing with children of as young an age as possible, preferably from birth upwards. This she should do under the guidance of someone who is skilled and experienced in their care. She should have practice in bathing, dressing, putting to sleep, and attending to all the needs of, a baby. In this way she will learn a great deal that is of practical importance and will gain that confidence and

sureness in handling the child that contribute so much to his sense of security and peace. Any errors that she may make in learning will not have the same ill-effects for the children in question as for her own child; in the first place because she will be an occasional rather than the chief attendant, and in the second place because, not being the mother, she and her doings will not have the same significance. This previous experience may do much to curtail anxiety that is likely to arise in dealing with a child of her own. That a woman should be expected to learn all the details of nursing, and to carry them out with assurance at a time when she is easily tired and perhaps readily perturbed after her confinement, is unfair both to her and the child. In ways of life where money is short and children numerous, this experience is usually gained naturally by helping relatives and friends; but where there are fewer children and more nurses this does not happen so readily. This preliminary experience is to be recommended whether the mother is to look after her child herself or to employ a nurse.

A great deal has been learnt in recent years about the ways in which children develop and about the things that help and hinder them. Some of these will be touched upon in the pages that follow. But if there is one thing that stands out above all our other discoveries it is the importance of the parents' attitude towards one another as well as towards the child. If the parents have love, confidence, and understanding with regard to one another, they have the best chance of developing such qualities towards and in their children. They can provide that security which is the first essential to good development and are in the best position to profit by their own experience, and that of others in the details of upbringing.

The New-born Child

The human child is born into the world in a condition of very great helplessness. A lamb or a calf is able, very soon after birth, to stagger to its feet and seek out its food. Rapidly it develops other accomplishments. But it is not so with the human. The baby needs after birth an environment which is not so very different from the womb from which he has come; or he will not be able to live at all. He needs, for example, an even, warm temperature, as he had when within his mother's body; he needs a restful place in which to spend the greater part of his time in sleeping; he needs careful support when he is nursed or carried; and he usually needs some protection against bright light and sudden loud noises. All this the careful mother can provide for him fairly easily, and by doing so she is doing much to lessen the shock of his new surroundings. But even though the peaceful conditions of the womb are to a certain extent continued after birth, life in many ways is very

different. Of paramount importance is the new way of feeding. Other things are new, too—breathing, for example. But this begins at birth and goes on all the time. The child does not have to do anything about it. But with food the matter is different. This does not happen automatically or go on all the time, and he has to do something about it. When he wakes and feels hungry, he cannot run to his mother as the calf does; but he can cry and then she will come—or perhaps she will not. It is just these situations, where we want something and may get it or may not, that arouse us to a state of acute consciousness, and bring all our faculties into play. So with the baby. His first great interest in life is his mother's breast. The feeding situation brings an easing of the tensions and distress of hunger, some of his most important discomforts; through lips and tongue he makes an actual, pleasurable contact with something that is outside and apart from himself, and through it he gains consolation and satisfaction. He has feelings of contact with the breast and the taste and touch and warmth of the milk in his mouth and throat, together with the appeasing of his hunger. And with this go feelings from other parts of his body produced by the position in which he is held and nursed. The sense of pleasure and comfort pervades the whole situation.

The importance of this early feeding must be stressed for many reasons. It is the main source of comfort to the baby, what he always seeks when anything feels wrong. It introduces the beginnings of knowledge of the outside world, and it is the first relationship with another human being—or perhaps rather a part of a human being—that he forms. It is a situation, moreover, that is not merely important during the first months of life and is afterwards quite blotted out. Probably no mental experience of any moment is ever quite blotted out. We have already seen that there are many factors in the situation and each takes on the pleasurable, satisfying feeling of the whole. Long after the child has ceased to feed from the breast he will find pleasure and satisfaction in being nursed. Even much older children, if they are ill or hurt, will sit in the laps of parents or other adults and snuggle up against them to be comforted, sometimes also sucking their thumbs. A good deal of this attitude is apparent still in the embraces of adults. What was so all-important for the baby remains important throughout life.

It is now clear that the feeding of the baby has to be taken very seriously. It can be said quite definitely that, for the sake of his mental no less than of his physical health, the mother should feed him herself if she possibly can. She should be able to feed him, too, with confidence and without worry, so that she can give him the greatest sense of security. This is something he needs fundamentally—as a back-

ground, as it were, to his future life. It is often said nowadays that women are too lazy or too pleasure-loving to feed their babies. Undoubtedly, this is frequently so; but it is perhaps worth pointing out that the objection quite often comes from the husband, who wishes his wife to be free to go about with him and resents the tie that breast-feeding imposes. This position is a particularly unfortunate one, since the mother needs the support of her husband in what she is doing if she is to have that assurance which helps a regular supply of milk and leads to the best handling of the child.

But there are cases where breast-feeding is not possible. Here every effort should be made to make the situation as like to that of breast-feeding as may be. The baby should be nursed in the arms and the mother should herself give the bottle, so that he may begin to learn something of her, her way of holding him, her voice and appearance, and learn this in connection with the satisfaction that he gains from the food. If the child is handed over to a nurse for his feeds, it is she who will become the figure typifying the pleasure and comfort of satisfaction. This is least harmful where the nurse occupies a permanent position in the household. What happens all too often, however, is that the mother decides that she will not breast-feed the baby, leaves him to the nurse, and then, since she does not feel inwardly very happy about it, begins to find the nurse at fault and finally dismisses her. It must be remembered that a nurse holds a very important position for the baby. Where she and not the mother feeds and looks after him, a change of nurses must be about as disturbing as a change of mothers. If a nurse is to be employed, obviously the greatest care should be taken at first in choosing one who has the right qualifications. But once the choice has been made every effort should be made to avoid a change.

It has been said that the feeding situation offers the main solace to the baby. It is what he seeks naturally when in distress. Obviously, the child cannot always be fed when he wishes it. This would often be bad for him and only add to his troubles. But there are ways in which some elements of the feeding situation can be used to give him the comfort without the food. One method, which we often see, is by giving the child a dummy to suck instead of the breast. In a way this certainly works. It calms and soothes him. But it is a bad way. Apart from drawbacks from the physical point of view, it is giving him his satisfaction in, as it were, a self-centred fashion. It is in no way advancing his knowledge of the outside world nor bringing him nearer to a knowledge and love of other people. We see the same technique adopted very readily by the child himself in sucking his own fingers or thumbs, an activity which may begin fairly soon after birth. Usually it is abandoned quite spontaneously, but where it is

continued into later years it indicates probably that the child is or has been unable to turn all that energy which was at first directed towards the mother's breast into more useful channels. Parents and nurses often become very much disturbed by this practice, which in itself seems to be a comparatively harmless one. The remedy must lie in offering the child other attractions, in aiming at fuller interests and happier family and social relationships, rather than in forbidding or preventing the habit. Usually far too much attention is turned to the symptom, and the anxiety that is felt is often quite unnecessary. The number of babies who suck their thumbs is very large. The number of schoolchildren who suck pens and pencils, and of adults who do the same sort of thing with pipes and cigarettes and cigars, is probably much larger still. And nothing very dreadful seems to happen to them. In any case, drawing attention to the symptom or introducing strict prohibitions is likely only to be harmful.

Sucking has the greatest attractions for the baby. By giving him a variety of objects, not to suck passively and monotonously as with the dummy, but rather to suck and bite and explore generally, this activity can be turned to good use.

So much, then, for the sucking. What of the other aspects of the feeding situation? An important one is the nursing in the arms which goes with the feeding. This is clearly pleasurable and comforting to the child, both in itself and through the association with the food. It is the good and natural way of consoling the child. For babies do need consolation; they have discomforts and distress for a number of reasons; and, apart from the attentions that their mothers and nurses can give, there are few ways of relieving them. They need to be loved in the quite primitive way of being nursed and fondled, and the mother usually needs to find expression for her own love in this way if she is to be free from anxiety. Young mothers nowadays are told that the baby should not be taken up whenever he cries, and so on. Most intelligent people have by now realized the truth that lies behind this advice, but some perhaps learn the lesson too well. When a mother sits miserably watching the clock in one room while her baby screams in another, we realize how easily a little science can make martyrs of the best of us. It may be said straight away that a natural and affectionate handling of the baby is perfectly consistent with regular feeding and sleeping times, and that where the mother has a happy relationship with her husband there will be little tendency to sentimentalize over the baby or treat him as a plaything. The important thing is to look upon him from the beginning as a human being. He comes into the world neither to be a comfort to his parents nor to be a specimen for the laboratory, but to be a child, and a child who will grow continuously to adulthood, developing his own interests and abilities and personality.

The Child and the Family

Feeding and sleeping in the beginning occupy the main part of the baby's life, but as time goes on the intervals of wakefulness grow longer and he has fuller opportunities of exploring his world. At first he attends to very little beyond the breast that feeds him, and this he knows mainly as something to be sucked. Soon, however, he becomes interested in other aspects of his mother; she is something to be seen and heard and touched as well, and these different aspects combine to make her a person for him. He becomes interested in other things that can be known, both in his own body and in objects that he can hold and, if possible, put to his mouth. For the lips remain the most natural means for learning about things for quite a long time. He takes great delight in the free movement of his limbs, in kicking and later in turning about and moving his whole body. As these interests and abilities show themselves, the child needs the means of developing them: opportunities for movement so that he may learn to move better and better, the kind of objects that he can explore with hand and eye and lips and, when his teeth begin to come, with these too. The growing interest in things around him affords him many new pleasures and leads the way to new knowledge and new achievement. At this stage the crying child can be made happy when given a new object to handle or the chance to kick and move freely. And through all this he learns.

So long as the child is unable to move himself about, his world remains a comparatively small one. As soon, however, as he can crawl, it enlarges tremendously. He can now go from place to place and takes huge delight in doing so. Space becomes of great importance to him. His desire to crawl from room to room of the house and round the garden is extremely strong. It represents his urge to practice his physical movement and his urge to find out things. The cottage where the child can 'follow his mother around' as she does her work is probably the paradise of this stage of childhood. This is a time when the child often shows discontent at confinement in the nursery, a fact which is not at all surprising. He has just learnt to move himself about, and finds a solidly fastened nursery-gate between himself and the world into which he is qualified to venture. It is not always easy to arrange, but the more the desire to roam can be satisfied the better. When the child can crawl, he is probably less eager than he was to test out new objects by carrying them to his mouth, although he will still use his mouth a great deal. He will explore endlessly with his hands, picking things up, fingering them, running his hands over the furniture, and so on. It is his way of finding out. 'Don't touch' to him is equivalent to 'don't learn,' and if we want him to learn we

have to put up with his own way of doing it. For many years touching remains of far more importance to the child, as a means of finding out, than it is to adults. It is for this reason that grown-ups, who do not understand children, usually find them unbearably meddlesome.

Already, when the normal weaning-time is reached, the child has a firmly established interest in the world around him. He has explored a great deal and found pleasure in a great deal over and above the feeding which was so all-important in the beginning. He knows his mother as a loving person and not only as a food-giver, and he knows his father and other people too. He now has much to compensate him for the loss of the mother's breast. Even new foods are not wholly unpleasant, for they give some chance of exercising the impulse to bite which is replacing that of sucking. He can soon use his hands, too, in feeding, and carry things to his mouth to new advantage. All encouragement should be given to the child to help to feed himself as soon as he shows that he wants to. The texture and appearance of foods soon come to be of importance to the child. In fact, the likes and dislikes of many children seem to be determined far more by these than by taste. They dislike a thing because it tastes 'slippery,' and will eat the most insipid mixtures if they are coloured pink and green and have a pattern on them. Usually until after puberty the child reacts to the appearance of food in a way that is different from the adult's.

We can now see the usefulness of the full period of breast-feeding, from the psychological point of view. It allows of weaning at a time when other interests and affections can do something to compensate for the loss that the child undergoes. The more interesting and friendly the world has been to him, the more confidence he has in his parents and his environment, the more easily is he likely to accept the new conditions.

In all that has been said about the child so far the mother has stood out as the principal figure. And this is true to fact. For in the first months the child's relationship to the mother is far closer than that to the father. He comes to know her earlier and better through her more frequent handling of him and through the intimate bond established through the feeding. Not only is his knowledge of her greater, but in the beginning he almost certainly loves her better.

All this is very obvious and very natural; but it may be rather hard for the father. It is a factor in parenthood that is apt to be overlooked and is well worth recognizing, for if it is recognized, there is no reason why it should prove a stumbling-block. Difficulties arise when the father does not for a moment admit that he feels excluded or jealous, yet finds that the necessity for regular feeding-times or the sight of napkins drying in the garden has an almost magical power of annoying him.

It is not long, however, before the father comes into his own, in a role that is of extreme importance for the child. He is well known long before the usual weaning-time and the child is developing an attitude to him which is somewhat different from that to the mother. Her first and, for a long time, foremost function is in feeding him, and in doing this she is supremely good and desirable. But at times she does not feed him when he wants it, and, at weaning, withholds the breast altogether. In this, she is very far from good; in fact, she is quite the reverse. Thus the passions that are directed towards her, especially when the question of weaning arises, are apt to be very conflicting. We may sometimes see this conflict expressed in the child's attitude towards the breast itself, for scratching and biting as well as sucking at the nipple are not at all uncommon.

Apart from matters connected with feeding, the mother, by the time weaning is reached, is probably exerting a not altogether welcome influence in other ways. For she will already be training the child in habits of cleanliness. Careful as she may be to praise success and avoid blame at failure, her attitude still cannot be quite that of ready acceptance of whatever the child does. She is beginning to discriminate his good actions from his bad actions. The child fairly clearly finds pleasurable relief in evacuation, but he learns now that his pleasure is not always reflected in his mother. He may find that what is good to him is bad to her, is met with reproach, or at any rate has a quite unenthusiastic reception. She will not always welcome his 'good' with signs of love and pleasure, and where she does not do so he very readily takes her to be hostile and frustrating.

The father, however, has probably not had quite the *supremely good or supremely bad* kind of relationship with the child that the mother has had, and thus, in a sense, may be an easier person to get on with. The building-up of a firm affection towards him is of first importance. Physical contact and satisfaction do not play the same part in it, but a common interest in achievement and the things of the world around enter into it very largely. While some mothers, at any rate, like babies so much that they would be happy always to keep their children at this stage, fathers usually have a strong wish for their children to advance, so that they may be able to share their interests and occupations. The love and interest of the father are of the greatest help to the child in overcoming the dependency of the early months.

Under normal circumstances, then, the mother is the first figure of importance for the child, although the father very soon enters into the picture. It will be worth while to look now to the child's attitudes towards people in the years that follow weaning. As a rule the details of these are extremely complex and hard to disentangle, but there are certain things about them that need to be kept in mind.

In the first place, the child's passions and affections during the early years are centred almost entirely within his own household. Mainly they are concentrated on the parents. The full strength of his feeling, which is very considerable, is directed towards them. As yet he knows little beyond the family and in general his knowledge is very small. His passions, too, have an intensity which is probably never equalled in after years. They are wholehearted. He goes all out. He is supremely happy when he is happy; his anger and rage are ungovernable; his terrors overwhelm him. We see how this happens. His feelings are strong; they are confined to comparatively few people; he lacks the knowledge and experience that would control them. When his parents are angry, everything he loves has turned against him. They are his world and they are angry. His terror and desolation are fairly complete. When his mother leaves him one day in strange surroundings, he feels left completely. His knowledge of past and future is extremely vague. It may be almost impossible to persuade a frightened child of two that his mother really will come back. It means nothing to him. She is gone, and that 's that. For young children live in the present to a most surprising extent. An older child knows when the mother goes away, even leaving him in unpleasant circumstances, that he will eventually see her again. The young child has to learn this. He really cannot look ahead so far, and so he feels left, and left absolutely.

The good factor in this way of living is that, once the child's attention is turned to something else, his mood changes fairly rapidly. It is far easier to console the child whose mother has departed by giving him something amusing to do than by trying to persuade him of the reality of her return.

This technique in dealing with him is useful in many ways. Pains from cuts and bruises and so on may cause real distress so long as the child's attention is directed towards them, yet vanish completely when he is led to think of something else. Incidentally, with regard to pain, it is worth remembering how large an addition of other feelings goes with it. One may see a child with a cut knee trot home quite happily, only to burst into tears at the first sight of the mother's concerned expression. Fear derived from the anxiety of others, or generated by the fuss made over the injury, readily combines with the pain to make the experience unduly distressing. How much, beyond pain, there is in our painful experiences can often be realized by watching a little girl having her hair done. Many children are extremely sensitive over this, and suffer even at the most careful combing. But give the child the comb herself, and she will often pull out large tangles by the roots with the remark: 'See, when I do it, it doesn't hurt.' We may compare, too, the gladness with which we suffer knocks in the interest

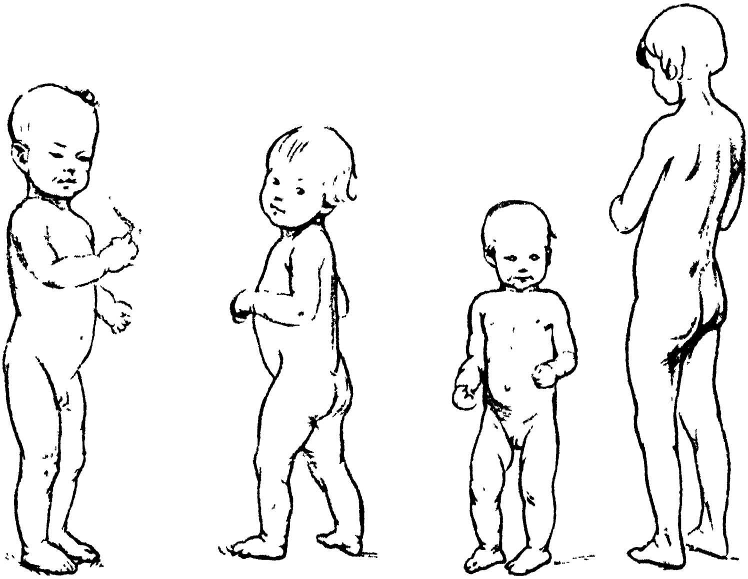
of sport with our feelings at the first touch of the dentist's drill. In dealing with small children it is of the utmost importance that their injuries, and for that matter their illnesses too, be treated in a matter-of-fact manner without the show of anxiety that will make the child himself fearful.

To return to the emotions of the very young child. We find in him a strong tendency to believe that whatever happens is happening to himself, is directed towards himself. This would seem to account in part for the overwhelming effect produced in him when the parents quarrel with one another. Most parents quarrel from time to time, and very many do so in front of their children. If they could find leisure to give an eye to the child who is present, they would quickly realize what a devastating process it is for him. To a large extent, anger of any sort is terrifying to him; anger between the parents is especially so because of the closeness of the child's bond with them.

When grown-up people love or like each other, we have a relationship something like this: 'I am I, you are you, and I like you.' But with the child it seems to be different, for there is very little 'I am I' about it. He has not any very clear notion of himself. He is only in process of building this up through his relationships with his parents and other people. He does not stand away from his world with any kind of detachment. He is building up his own personal attitude towards people and things only slowly, and is doing it largely through *being like*, now one, and now the other, of his parents. Perhaps it would be better to say through *feeling* himself, now one, and now the other, of them. In so far as he feels himself as one of the parents, quarrelling between them becomes for him an attack upon himself. When, as is probably the case, he has this feeling with regard to each of the parents, it becomes a strife within himself—something even more overwhelming.

The immediate moral of this would seem to be: 'Don't quarrel'; but there is more to be learnt from it than that. It points us to some of the features of the child's way of loving. This at first is modelled to a very great extent on the adult way, a fact that is not at all surprising when we remember what an important theme the parents are for the child and how closely he is actually associated with them. The child wants in the way of love quite a lot of what the parents have. We find the little girl behaving like a loving wife to her father and the little boy like a good husband to his mother. Sometimes these attitudes chop and change, the boy taking up a more passive and feminine position and the girl a more dominant one. Throughout the first years of childhood, we find children's wishes towards their parents extremely imperious. They want physical contacts. They want possession. They are capable of violent jealousy, not only with

regard to brothers and sisters but with regard to the parents themselves. And they are fearful of the consequences of their passions. As a child of seven once expressed the matter to the writer: 'You know, it 's so difficult to love two people. It *feels* so much as if one of them must be angry.' In this we have a clue to a good many of the fiercer troubles of the early years. The child loves the parents; in his feelings and wishes he usurps the place now of one, now of the other of them, and



FROM INFANCY TO CHILDHOOD

feels that some sort of retribution is due to him for this, probably of the same crude kind that he himself would mete out to the usurper.

In dealing with children during the first years, we have to remember how much they are creatures of passion; how little there is to modify or ameliorate the passion; in fact, how generally vulnerable they are. We may consider the bearing of what has been said on the question of whether the child should sleep in the parents' room. Clearly where he does so his feelings are likely to be aroused to their full extent. There is the bed which he very definitely wants to occupy and he mustn't go into it. There is warmth and bodily nearness—the sort of things he once knew when his mother fed him, but had to give up—and they are all for other people and not for him. If his desires for all that is comforting and pleasurable are aroused, his jealousy and resentment at being kept out of it are aroused equally. Where, as sometimes happens, the parents have intercourse in the child's presence, the effect would seem to be greater still. For now he is beset not only

By courtesy of the Trustees of the British Museum

A MATERNITY SCENE

Twins safely delivered. Fifteenth century

with the feelings that occur when they show affection to one another and not to him, but with those feelings, too, that he experiences when they quarrel. For there are actually strong elements of fierceness in intercourse, and the effect of these is to arouse the same sort of terror as anger does. Moreover, the scene is so mysterious and so charged with emotion that it can be given no sort of place among ordinary happenings, and so is specially apt to produce in the child disturbances that are far-reaching and difficult to cope with.

Parents nowadays usually give the child his own room at an early age whenever it is possible, and this is certainly to be recommended. Very many people, however, make exceptions of special occasions, such as holidays. It is instructive to find that the same parents often complain that these holidays are really not very much fun. The child in question becomes so tiresome and impossible to manage.

If the child is capable of very mixed feelings of love and anger, fear and jealousy, where his parents are concerned, the same is true with regard to the brothers and sisters—especially the younger arrivals whom he sees taking the place he held. A good deal of the child's feelings on the subject are summed up in the saying of a little girl of 3½, an only child: 'Mummy, I do wish daddy would give us a baby. I 'd look after it and bath it and all that, and smack it when it was naughty.' We see how the child associates herself with the mother, 'give us a baby,' and how she is ready to take the mother's place and possess the baby herself. We also see how ready she is to vent on it her feelings of fierceness and superiority. Children often become profoundly disturbed at the birth of a younger child, and this disturbance may show itself in many ways: in destructiveness, in timidity and fearfulness, in aggressiveness towards other children, in restlessness, inability to sleep, night-terrors, masturbation, and so on, and so on. Some of this is probably inevitable, but care on the part of the parents can reduce it a great deal. In the first place, the mother and father can avoid hurting the child's feelings too violently by displays of affection towards the baby which leave the older child out in the cold. They must, in fact, make special efforts at this time to prove to him that their feelings towards him are unchanged. They can lessen the child's worry by avoiding any air of mystery. The child usually knows a great deal more than is realized about the mother's pregnancy, and it is far better to satisfy his curiosity on the subject than to allow him to elaborate his private suspicions. He needs to be taken into the parents' confidence in the matter, or resentment at being deceived will be added to his other troubles. He needs, too, to feel that he is co-operating—that the baby is something for him as well as for the parents. To go back to the little girl already quoted, she could not be allowed to bath a new-born baby; but there

are many ways in which an intelligent mother could satisfy and encourage her truly maternal feelings by letting her do small jobs in connection with the nursery. She could let her feel that to some extent the baby was for her. It is when the child feels: 'You have got the baby and I have not; you have got a baby and now you don't want me,' that the real difficulties arise.

During the first few years, then, children live very much within the family, and their desires are in a way very adult in character. They are very much concerned with family life and yet can never quite play the part they would like to play in it. They cannot be mothers and fathers at the age of four; they cannot take exclusive possession of parents whose affections have to be divided not only between one another but between the other children in the family. So this way of living eventually brings children up against reality with somewhat of a shock. Setting all his heart upon the father or mother, feeling himself into that position, does not bring the child all the good things that come to the parents. Rather it leads to a good deal of disappointment and frustration and often an almost intolerable mixture of love and anger.

It is really the rather intolerable character of the child's position when all his loves and hates and ambitions are centred within the family that drives him on to further development. But it is usually not easy for him, and we may find innumerable signs in normal children of the strain that they undergo. General unmanageableness, shyness, timidity, aggressiveness, destructiveness, enuresis, masturbation, fears, and night-terrors are all among the symptoms that show themselves frequently.

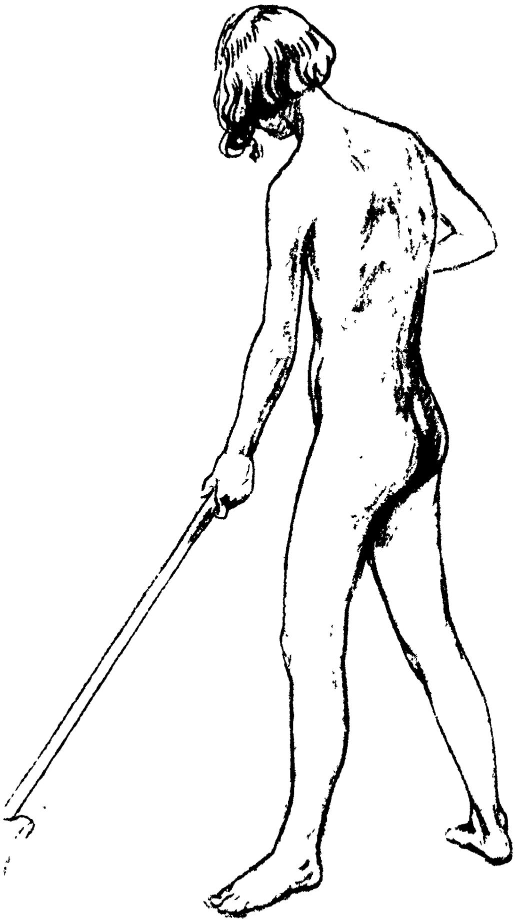
There are various ways in which the parents can help the child during these first difficult years. In the first place, they can let him feel the assurance of their affection, not only when he is good, but when he is naughty too. They can shield him from the effects of domestic conflicts and bear in mind that any steps which they can take to make their own lives happier and more peaceful will be the best medicine for him. Through understanding what is happening to him and the fairly common nature of his difficulties, their own resentment or anxiety over his behaviour will be likely to give place to a calmer and more tolerant attitude. And they can do much to facilitate the solutions of the problems towards which he himself is driving.

Making Friends

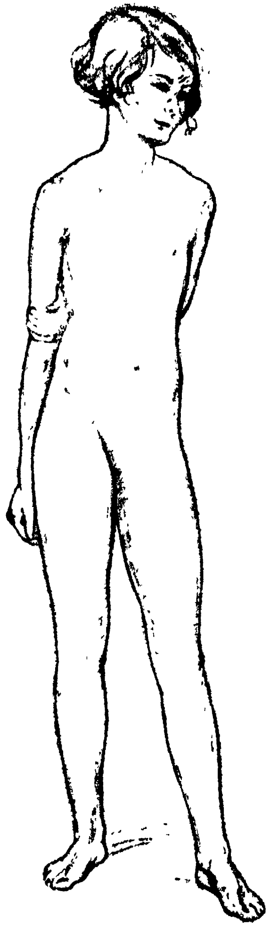
It may be well to look now to some of the ways in which the storm and stress of the early years are alleviated with further development. We may trace out one or two natural lines of growth which make for

an easing of the early difficulties accompanying an advance towards maturity. It is by facilitating such development that the parents can most easily help the child.

In the first place, with intellectual growth a great part of the energy



THE YOUNG GIRL (I)



THE YOUNG GIRL (II)

that formerly spent itself in emotional ways comes to be absorbed in the acquisition of knowledge and skill. Through this the child gains real mastery of his environment and actually approaches step by step towards the position of the adults whom he admires.

Play helps him extremely. Not only does he learn thus to better his actual achievement, but it is a means of expression that gives him an indirect satisfaction for many of the desires that are thwarted in reality.

As time goes on his social environment enlarges. New figures enter into his life; he takes more and more interest in other children and other grown-up people; the feelings that at first centred almost entirely around members of his family are extended to other people. He is no longer quite so much in the position of having all his eggs in one basket.

Along all these lines of development the parents can help the child a great deal. In so far as the child's energies remain directed towards themselves, they really help best by being the right sort of people to be parents; but here they can help also by means that are much more under their control.

To consider first the last line of development, the extension of the social environment. This begins very early, and begins in the main with adults. The child under three usually turns his affections far more readily to grown-up people than to other children. Nurses, maids, relatives, neighbours, or friends of the family are probably among the first of these new loves. Under two years old he may already appreciate having other children around him and will enjoy carrying on his own occupations in their company. It is, however, usually not until after three that children co-operate to any extent in games and really play together; but even before this the companionship is valuable. Parents do well to see that there are opportunities for this social expansion, that there are friendly adults and children about. They must remember, too, that the child has no sense of social distinctions, and that the maids in a house or the charwoman's baby may become for him as important, or more important, than all his parents' acquaintances.

The need for the companionship of other children is most striking with the only child. But even in larger families the need exists to make friends outside the home. By doing so the child finds a way of countering and relieving the stresses of his own home life. He can know other children without quite the intense feelings that come from having parents in common. There is a greater freedom and equality. He is not inevitably in the position of being the youngest or the eldest or whatever it is that he has to be at home. The rivalries and jealousies that occur are less intense when compared with those of the family, and the fact of experiencing these feelings in such a lessened form and in relation to a wider circle of people tends to make the actual home-life easier. Amongst a group of children we may often see those who are the youngest in their own homes making up for this by playing the elder brother or sister towards their friends. The eldest of a family may gain equally by being with children of his own age where he does not have to be responsible and protective as he would with his own brothers and sisters.

Ample opportunities of companionship are essential to the building-up of the child's character. With the very small child we saw that the relationship with the parents was very much that of being like them, of identification with one parent in relation to the other. The grown-up, when his attitude is a good one, meets his parents as an individual having his own opinions, likes and dislikes, his own developed and independent personality. This is essential to his good relationship, not only to his parents in later life but to the world in general, and he gains it by gradually extending his likes and interests beyond the family, by modelling himself not only on the parents but on a succession of other individuals, by belonging not only to the family group but to a number of other groups quite apart from and different from the family. This process would seem to begin with the first social relationships. The child of three or four already finds tremendous support in the alliance with his playmates and his friendships with other adults. The child of eight may come home to his parents with: '*We* don't do it like that . . . *we* do this . . . *we* do that . . .', where the 'we' refers perhaps to his class at school. He has already got a firm foothold in a group that is apart from the family and is bringing into his family relationships something which is his own and has its source outside the home. He has achieved a measure of that mutual independence that is essential to good understanding between human beings. He is able to criticize, and the bond with the school group has helped him to do so.

As an adolescent, maybe, he no longer says: 'We do it like that.' His ties with his friends are now so much closer, his own interests so much more passionate, and his feelings towards his family so much intensified, that he may not be able to express his criticism so simply. Rather he may tend to shut himself off from his parents or break out violently against them. At this time his instinctive drives become so powerful that it is extremely difficult for him to bear the disquiet of his feelings towards his relatives. At the same time his feelings for his friends and their ways and ideals are equally intensified. Now, more than ever, friends are necessary for him, and at the same time he needs more privacy in his own home. As his loves take on more and more of the sexual character that goes with genital development, his position—where his affections are confined to the family—becomes increasingly difficult. At adolescence, many of the mixed feelings about the parents, which make themselves so apparent during the first four or five years of life, are revived. He escapes a great deal of these difficulties by turning to people who are not related to him. In doing so he achieves sufficient emotional independence of the parents to make it possible finally for him to fall in love and marry. Where there are no opportunities for making friends, for developing enthusiasms,

for taking on new cults and generally getting away from the traditions and personnel of the family, there is small hope that development through adolescence to maturity will be achieved normally.

The parents play a great part in providing the necessary social environment for the child. They can look out for signs that the small child is becoming interested in other children and take steps to provide companionship. If parents followed the inclinations of the child rather than their own, many more children would find their way into nursery schools and classes. In most cases this is by far the most satisfactory way of helping the child, for thus he can meet other children of his own age on neutral ground. Where no such school is available, it may often be possible to arrange for a number of children to play together, although for many reasons this is not so satisfactory as the nursery school.

As time goes on companionship becomes more and more necessary. The need for it in later years is, however, more generally recognized, and, in any case, compulsory education normally does something towards it in the end. Usually it is only with delicate children and in comparatively small sections of society that governesses and tutors replace the school for long. It is during the early years that companionship is often lacking and its importance overlooked. When only children are allowed, as sometimes happens, to grow to be five and six years old with scarcely another child to play with, it is scarcely surprising that it should prove hard for them to get on with other people when they do meet them. They have had for so long to do without the friends they needed that they have been compelled to fall back on other less profitable or less comfortable satisfactions. We may find children in this position inventing companions, imaginary playmates, to take the place of the real ones. Often we find them shy or hostile or miserable when they first have real children to play with.

It is up to the parents, then, to see that the possibilities of companionship exist, and, if they wish to guide their children's development, they need to consider carefully the sort of people with whom they are to mix. For children very readily adopt the manners, tastes, and ideals of those around them, especially of those they admire. This is not just weakness or waywardness on their part. It is an essential feature of their development, of the building-up of their characters. It is unreasonable to find a child other children to play with and then be annoyed if he adopts their accents, habits, and mannerisms. He needs to do so; for it is a way of learning, of trying out new things, and it is an expression of the bond with his companions. One may sometimes hear an annoyed parent say to a child: 'Why must you always copy So-and-so? Why can't you be yourself?' This is a quite illogical demand. The child's self is a developing entity that grows

largely by absorbing and reproducing what he finds admirable in those around him. The part the parents can play is in so arranging life for the child that he has opportunities of making such friends as they themselves would not dislike. Thus, in choosing a school, the character of the children in it, and of the staff, must be a consideration of as great importance as the quality of the teaching.

The child will adopt a very great deal from the school and from the various other social groups that he enters. The parents need to let this happen. They can make things easier by choosing an environment which is not too unlike their own, one with which they are more or less in sympathy. Where there is a marked difference between the tradition of the home and that of the other groups that the child enters, they must be prepared to accept the results of it. They only hamper the child's development when they emphasize these differences or urge him to resist outside influences; for the child cannot follow only in his parents' footsteps and still remain healthy.

With the passage of the child into the wider society beyond the home, practical problems nearly always arise. The parents usually find things that they dislike in the school, however good it may be, and they usually disapprove of some or many of their children's friends. Where the objection is on purely reasonable grounds, it probably does the minimum of harm. The trouble is that most of us really want our children to be second editions—somewhat revised and improved—of ourselves, and our resentment at their departure from our own way of living only too readily takes on the guise of reasonableness.

It is often not easy to gauge the importance which the ways of new social groups have for the child. When a particular fashion in hair-slides or shoe-laces looms so large that any suggestion of departure from it is met with storms of protest, we have to remember that this may be a way of representing the solidarity of the new social group. In attempting to substitute a new kind of hair-slide, we may be attacking that solidarity, demanding of the little girl that she break away from her allegiance to her fellows and forfeit their support. For her it is not so small a matter as it appears. Our demand arouses the conflict between her feelings for her parents and her feelings for her fellows. Hence the storm. As parents we should be glad that the bond with the other children is strong, for this is clearly a factor in healthy growth.

With adolescence, more definitely sexual elements begin to enter into the child's friendships both with adults and with those of his own age, and this not only awakens his own scruples and conscience but adds very much to the parents' concern. On the whole it may be said that it is not the sexuality but the anxiety over it that is the greater danger to the child, and whatever the parents can do to bring him to

realize that this phase of his development is normal and acceptable is to the good.

At this time we may expect preferences for members of the opposite sex to come strikingly to the fore. However, with a system of segregation in schools and colleges such as we have in England, the most frequent and regular companions of the maturing individual are often members of the same sex. The result is that these constitute the readiest objects for the now powerfully reinforced affections. Whether this is altogether a good thing is open to question. But with such a system we cannot be surprised if more or less passionate homo-sexual attachments frequently develop. Where they are felt to be harmful, a remedy is to be sought in fuller opportunities for hetero-sexual companionship rather than in prohibitions and moralizing. Ordinarily the boy or girl leaves this phase spontaneously and naturally as the sexual impulse reaches its full strength.

Through the enlarging of the social circle, then, the feelings that were at first concentrated within the family are more widely distributed, giving some measure of relief to the tensions of the early years, and making it possible finally for the individual to adopt an adult way of living. The parents need to give their help to this social development and to be prepared to relinquish their children more and more to the outside world. It is the best, in fact the only, means of securing a real friendship with them. The parents who live and have their being entirely in their children and feel strongly possessive about them are not always the most helpful ones. Prized as their devotion may be by the child, it may yet make it difficult for him to establish his own position. This type of relationship arises perhaps most readily where one parent dies; but it also often arises when the parents find little satisfaction for their love in one another. The situation may be relieved by increased interests and opportunities for work so that they need to depend less on their children; or through wider human companionship. The parent who feels, or says to a child: 'Darling, you are all I have in the world,' puts a responsibility upon him which he should not be asked to bear. Children need more or less contented parents if they are to grow up as happy and well-poised individuals.

Learning

Social relationships provide one way in which the child's energies are absorbed and redirected. Intellectual development provides another. As the child grows, much of the energy that spent itself in emotional ways is taken up with learning, with finding out and acquiring skill in doing. Learning begins at birth with the first stimulation of the

sense organs and the first movements. When the child can handle an object, can touch a thing that he looks at and carry it to his mouth, he has already learnt quite a lot. Gradually, with practice and the strengthening of his muscles, he learns not only control of hand and eye but of his whole body. He learns to stand and walk, and the parents greet the accomplishment with great triumph. Usually they take pains to help the child in this respect. However, when the child has learnt to walk, he is still only in the early stages of acquiring bodily control. His balance is still poor, and it is many years before it is perfected. He has to learn to run after he can walk and he needs space for this and freedom to practise it. A small child does not easily walk quietly and steadily. Walking, running, stopping altogether, and then going on again are his natural way of progression. He needs many opportunities for acquiring balance, and for this purpose things to climb over are most desirable. A variety of apparatus exists to meet these needs of children—steps, boxes, jungle-gyms, etc.—and where there is plenty of space and no need for economy it can be very useful. Nursery schools are particularly fortunate in being able to provide material of this kind for the children who attend them. However, there is no point in cramming a small nursery with expensive aids to development and so reducing the necessary space for movement. Often all the needed opportunities can be given by relaxing the rules about not putting one's feet on the furniture. An old sofa gives excellent climbing, and, although the springs certainly suffer, the child gains.

And it is not so very long before he grows too big to be interested in the sofa and prefers climbing trees. Wherever there are trees to be climbed, children—both boys and girls—should be allowed to climb them. They are an ideal form of apparatus, presenting endless variety and calling for ingenuity and control of the whole body. The wise parent devises clothes that are suited to the purpose and does not complain of the ensuing dirt and untidiness. Children, being on the whole less vain than adults, have not the same incentive to look clean and well-kempt. To them climbing trees is far more important, and it is quite right that it should be so.

Swings are a form of apparatus supplied fairly commonly to the child, and they give very great pleasure. Perhaps even better is the swinging bar, or trapeze. If, instead of the seat of the swing, a bar be fixed at about the height of the child's shoulders, it becomes susceptible of many more uses. The child can sit on it and swing, hang by its knees and swing, and practise acrobatics of various kinds. Skilful children from about five years old onwards are usually really interested in this, and they learn far more from it than from the ordinary swing. Sometimes ropes for climbing can also be fixed and they are

an additional boon. Where there is no swing, a bar for hanging on and turning somersaults can sometimes be devised.

These forms of exercise, climbing trees, playing on bars and ropes, etc., are particularly good, because in them the child exercises not only the lower limbs but also the arms and trunk. How intent and absorbed children become in hanging on to things, pulling up with their arms, and climbing on to them, can be seen by watching any group of children with a suitable railing. To the children who are not allowed to play on railings some substitute needs to be given. When the child reaches school, the gymnasium provides excellent opportunities; but in most schools this occurs as a more or less isolated event. It needs supplementing.

We have to remember that the child is by no means as content with just going for walks as are older people. He needs more varied movement and more imaginative content to his activities, and he supports the fatigue of continued exercise of one type badly. Thus dancing, climbing, and the various forms of gymnastic exercises all appeal to him, and interest in these may appear very early. It is up to the parents to watch for the beginnings of such interest and to use what means they have to cater for it as soon as it appears. It is impossible to lay down fixed rules, or mark out definite stages of development in these respects. There is only one rule to follow, and this applies to dealings with the child throughout its whole mental development. The parents must follow the child, must watch for the interests that develop, and supply the necessary means for meeting them as they develop. To put a child off with: 'You 'll have to wait for that until you are older,' should be avoided wherever possible. He will learn far better if he learns when and as he wants to, and he will not have that sense of the thing being forbidden which so often makes later learning difficult. This applies to the acquisition of knowledge equally with that of skill. In having the opportunity of watching the growth of the individual child, the parents as educators have an enormous advantage over the school. The teacher can usually only give what seems best for the group and this is probably not ideal for any one child. The parents can know and supply the needs of the individual, and the help that they thus give is an essential supplement to the work of the school.

Skill in finer and more precise movements grows as the child develops. To begin with, this is very small. We can see the young child using his whole hand to grasp with, then learning to hold things with thumb and finger. His early attempts at drawing are often made from the shoulder, and only gradually does the activity become confined to smaller groups of muscles. We see, then, that play material must be adjusted to these capacities. We cannot expect the very young

child to deal with delicate and intricate things. He needs good-sized pencils and brushes and large sheets of paper for drawing and painting. Children build with large bricks before they do so with smaller ones, and enjoy making things out of canvas and coarse wool when finer sewing would still be impossible for them. We may waste much money and labour in procuring material which is too advanced for some children, and we may insult another child unforgivably by offering that which is appropriate to an earlier stage of development.

Individuals appear to differ very much in their ability to do things with their hands. These differences are in part probably innate, but parents can help the apparently clumsy child a great deal by giving him confidence, by trusting to his success and not stressing his failure, and by giving him the sort of material that they see he can deal with. Sometimes the clumsiness of the child may be on a par with that of the housemaid who inadvertently smashes something every time her mistress scolds her; it may perhaps indicate a real, though quite unrecognized, desire to smash up all that he loathes; and here it is a happier adjustment to his environment generally that is called for.

Learning to do things with hands and limbs and body continues throughout the child's life, and he spends a great deal of his energy in this. Only the very dull or ill or unhappy child sits quietly doing nothing. Healthy, intelligent children need a great deal to do, and we must not be surprised if they sometimes tire rather quickly of one activity and go on to something else. They will concentrate for quite long periods on things that interest them, but they will not always continue to find pleasure in something they have mastered. To curb the child's activity, to expect him to be quiet and passive, or remain unoccupied whenever it suits adult convenience, is to hamper his growth and to throw him back on to ways of living that are ultimately harmful to him.

The beginning of speech is as striking a landmark in development as the beginning of walking. As walking opens up for the child a much wider environment, speech offers a means of communication and self-expression which is far more efficient than any he has known before. Usually the child of a year has one or two words that he uses and he understands a very great deal more. By two years old, he may already have a vocabulary of several hundred words. Children, however—even those who are equally intelligent—differ very much in this matter. We may sometimes find quite bright children who do not begin to talk until after two. Unless there are other signs of backwardness, the parents need not worry overmuch about lateness in talking. They can make sure that the child is not growing up in too silent surroundings, and that such attempts at speech as he makes are received simply and without fuss and commotion that will embarrass him. They

may try to procure child companions for him if there are not already elder brothers and sisters, since there is a certain amount of evidence to show that this helps in the acquisition of language. Beyond this they cannot do very much.

A word may be said here about the use of *baby-talk* by adults, that medley of made-up and distorted words that is so often meted out to young children. There is no reason to suppose that this is of any real help. Although it may lead to increase of vocabulary in the beginning, it means a good deal of unlearning and relearning later on. It must, too, be discouraging for the child to find out that what he has acquired so arduously is only an inferior brand of language kept peculiarly for himself. Children learn very readily from simple, normal speech and gain far more confidence from this than from learning a language that marks them out as babies.

The parent or nurse who persists in the use of baby-talk to a child probably does really prefer him as a baby and would like to keep him such. This attitude is one that makes growing up very difficult.

Language gives the child a new means of mastering his experience. It is the same with all of us. When we can put a thing into words it is more or less all right. We say we can't find words for it when the matter is really overwhelming. It would seem, then, that the more the child's vital and important interests come to expression in words the better for him. To tell a child: 'No, we mustn't talk about that,' is to prohibit this means of dealing with the situation. If he may not talk about it, he may at least worry about it, and this, in one way or another, is probably what he does.

It may be well now to consider one or two of the more important interests of the child, particularly those with which parents sometimes find it difficult to deal. One about which much discussion has lately centred is the interest in reproduction. This interest is certainly amongst the most absorbing for the child. It is probably strongly developed in all normal children by four or five years of age, although it may not come to direct expression in words. There is small doubt that, when the child is wondering about how babies are born, about the differences between boys and girls and men and women and about what the mother and father do in order to have a child, it is far better for him to communicate his thoughts and receive information on the real facts than to continue to worry on his own. Having the matter in words does something to relieve the sense of mystery which is so extremely burdensome and allows the child to feel that knowledge, whether on this subject or any other, is not forbidden fruit. But with the best will in the world, parents may find the matter difficult.

A good deal of the difficulty is often already established during

earlier years. For before the child shows open interest in birth and sexuality he usually shows interest in the excretory functions of the body and the actual excrement which he himself produces. Curiosity with regard to this is perfectly natural. By accepting it and satisfying it, by giving explanations, where they are asked for, of how the excrements are formed and of the process of digestion, the parents are beginning to show the child that the interior of the body and its functions are not entirely unintelligible. The child would seem to be very much concerned with what is inside the body. He knows that food goes into it. He knows that when he cuts himself blood comes out of it. He knows that the excrements come out of it. These things he can learn from his own experience, but they are inadequate data to go on. Whevever the parents observe this curiosity, they should do their best to furnish the true explanations. We may find intelligent children acquiring quite an extensive knowledge of the workings of the body in this way, and in doing so they are turning to useful ends energy that would otherwise be used up in being painfully concerned about the matter without any kind of profit.

As important as, or more important than, the actual giving of information is the parents' attitude. Where they have shown much harshness or disgust or distress at his failures in learning habits of cleanliness, the child is likely to treat the excretory processes as matters where he can hope for nothing but hostility from adults. He will not then readily express his curiosity. Where he does so and is met with prohibitions, where the parents are shocked or embarrassed, he will receive yet another set-back in his efforts to establish communication with his parents on what is, to him, a very important matter.

Where there is failure to reach a tolerant and unembarrassed attitude over excrements, there is likely to be failure over the question of birth and parenthood. For the two matters are very closely connected, both in the child's mind and the adult's. The shame or embarrassment attending the one is likely to spread to the other. Where, however, the earlier curiosity has been satisfied, where the child trusts his parents to accept his interests, and not reject them as abnormal and unpleasant, he will probably readily come forward with questions as to how babies come to be born. When he does so these questions should be answered in the same way as any others that he asks. His asking them is a sign of healthy development. It shows that he trusts his parents and is seeking to find some solution of his problems through communication and increase of knowledge.

The ease and success with which parents answer their children's inquiries will depend to quite a large extent upon how far they themselves are in the habit of discussing the matters in question. For one thing, often a considerable knowledge of anatomy, physiology, and

psychology is demanded. Moreover, it is extremely difficult for people to explain a subject to children when they themselves have not been used to treating it in words. It is, of course, quite possible for the whole reproductive life of the individual to be carried through without any understanding of the processes concerned, as happens with animals. To a certain extent this is the case with many human beings too. It is certainly to be recommended that parents make some study of the phenomena of sex and reproduction themselves before they come to be tackled on it by their children. Here, it is hoped, this book may prove useful. So long as sexuality remains for the parents something about which a great deal can be felt and little known or expressed in words, any attempts that they may make to help their children will be likely to do more harm than good. For information needs to be given in a quite ordinary way as one would give information about history or geography or anything else that might be asked. Unless the parents are more or less at home in the subjects they cannot easily achieve this. The help that children receive from having their questions well answered probably lies as much in the assurance that the subjects are acceptable and not mysterious and horrifying as in the actual knowledge that they get.

Where the parents do find great embarrassment in these discussions, it is probably better for the child that they avoid them. They should, however, make sure that the child has opportunities of obtaining the knowledge he wants from some other source. Often a school teacher can help, especially at the nursery-school stage.

The fear is often felt by parents that, if they give information to the child concerning birth, procreation, and so on, his natural frankness will lead to embarrassing situations of one kind or another. There seems to be little ground for this. Unless the child moves in a circle where free discussion of all subjects is general, it is better to warn him that many people are capable of being shocked. He grasps this very readily and is usually very good at judging who will be shocked and who not. It is not as a rule difficult to give a certain amount of caution without letting the child feel that his knowledge is secret or undesirable. He is often rather proud of the superior position that it gives him.

If the child is intelligent and is brought up in a frank and friendly atmosphere, he will probably receive considerable information about bodily processes by the time he is about five. After this age the open curiosity often dies down somewhat, to be revived with greater strength at puberty. Sometimes a good deal of what was learnt in the early years appears to be forgotten. In any case a much fuller and more detailed knowledge is now needed. Nearly all parents feel it incumbent

upon them to 'enlighten' their children at puberty; but, if knowledge has been withheld consistently from the child before, this is a most unpleasant business both for the parent and the child. Many grown-ups still look back with horror at those serious and incredibly embarrassing ordeals of their own youth. The obvious method to follow is to supply information to the child as the demand for it arises and as the occasions of everyday life make it appropriate. In this way the need can be avoided of initiating the child at the sensitive age of puberty into what will certainly have become mysteries of the most unlovely kind. Where knowledge has been withheld by the parents or avoided by the child during earlier years, every effort should, however, be made to give it before puberty, although in these cases the child will probably show embarrassment and resistance and will not accept it after the natural manner of the younger child. To allow a girl to reach her first menstruation or a boy to be disturbed by erections and emissions without any understanding of the processes concerned is quite unforgivable.

It is probably best if both boys and girls are made familiar with the facts of menstruation from a fairly early age. It appears likely that in very many cases the child, while still young, observes some of the actual indications of the mother's menstruation, or at any rate hears the subject discussed. The notion of blood issuing from the mother's body under circumstances that are quite mysterious but in some occult way connected with her functions as a mother is one that it is very hard for the child to deal with by himself. Communication does much to lessen the mystery and reduce the anxiety aroused by these ideas.

It is often considered advisable to lead the child to an understanding of bodily functions through familiarity with the life-cycles of plants and animals. Certainly, keeping pets and looking after a garden are excellent occupations for children for very many reasons. Attention to the breeding of plants and animals may bring much knowledge that would not come easily otherwise. However, it must be remembered that what the child really wants to know is not so much how the rabbits mate, but how his mother and father mate; not how the baby mice are born, but how his baby brother or sister was born, and what the chances are of the same sort of thing happening again. To explain the breeding of animals and leave this as the analogy to the function in humans is unfortunate. For one thing, there are actual important differences; for another, more important perhaps, it still leaves the child's real doubts and worries untouched by adult recognition and acceptance.

Where children do not ever express their curiosity about sex and birth, the parents need to go warily. It is comparatively easy to answer

a child's questions as they are asked. Where they are not asked, it is probably unwise to press information on the child. The rather roundabout method, via plants and animals, may be very useful here. It is fairly well established that absence of questioning in ordinarily intelligent children does not indicate absence of curiosity. Often it is a sign that the concern is so great that conscious formulation and expression are prevented. Considerable care needs to be shown in dealing with children of this type.

The interest in reproduction has been dealt with at some length, partly because of its great practical importance in the bringing-up of children, partly because of its value from the point of view of understanding them. Watching the growth of this interest in our children gives us many clues to the puzzle of their development. Among other things, it allows us to glimpse the continuity in development from infancy to maturity. Possibly some will feel that the countenancing of such interests means good-bye to the age of innocence. But is that not perhaps a relief? Is it not preferable to feel that, after all, children are human beings like ourselves; that we do not need perpetually to be protecting their 'innocence' from our own implied lack of it? Another thing which we see very clearly in this interest is the fusion of emotional and intellectual trends. The child's powerful emotions supply the driving-power for his learning. We may see the same thing happening with many other of children's interests. Parents can observe it for themselves; space does not allow of following the matter further here.

Conclusion

We have seen how a great part of the child's energies are taken up in learning and in making friends. But he does not get all that he wants in this way. The turbulence of the early years—for they are turbulent: often outwardly so, inwardly always—is not entirely allayed. Many desires remain which are unfulfilled; many fears have still to be held at bay. In dealing with these, play helps the child very much. It is a natural safety-valve, a means by which he may discharge his impulses—whether of love, aggression, or what not—without the guilt and punishment that would follow them in reality, a way of achieving the longed-for and impossible. Disguised as the matron of a hospital, an engine-driver, or a duchess, a host of things becomes possible. In play the child may enjoy power, authority, wealth, may love, maim, or destroy, all with equal impunity. Often we may see the difficulties of the child's own life clearly dramatized in his play. In this he finds pleasure and relief. In some ways play resembles day-dreaming, but

it has many advantages over it. The satisfaction of play is achieved through speech and action and there is a constant calling upon reality. The imaginary hospital is filled up with oddments of pots and pans which constitute nursing and medical apparatus, often of a highly technical kind. The packing-case has all sorts of gadgets that make it very much more like a real fire-engine. Through play the child not only masters a great deal of his own inner conflict, but he learns a great deal that is useful and important. Neither parents nor schools can afford to overlook the value of play. It is all-important. We sometimes hear complaints that a child does not want to work; all he thinks about is play; children who do not play are a much more serious problem. Grown-ups do well to leave children alone as much as possible in their imaginative games. They need to arrange for the companionship perhaps, see to it that there are children well-suited to one another to play together, that there is ample space and some material to use. Beyond that, they can largely leave them to it. The chief virtue of the adult in this respect is non-interference—a virtue not easily acquired.

The attempt has been made to indicate some of the conditions that make for favourable development. But even given the best conditions growing-up is not without its difficulties. The child never gets entirely what he wants. No stage of life is quite without its fears, hatreds, and unsatisfied loves. We forget, of course, these difficulties. We think they vanish completely; but do they? It seems that the human mind preserves in an extraordinary way whatever is of emotional importance. However well our lives may be arranged, much of our energy seems to remain tied up with these forgotten troubles—tied up in such a way that, to use a very loose expression, we cannot control it but it can control us. We see it making its appearance sometimes in curious ways, in unaccountable fears, in habits that are annoying to other people and even to ourselves but which somehow make the world seem a little safer, in twists and kinks of character, and so on. We see ample evidence of this tied energy striving towards expression in the life of any boy or girl. There are few children who do not at some time or another have nightmares or night-terrors, who do not feel compelled towards masturbation, become absorbed in day-dreaming, give way to behaviour which is unreasonable and objectionable even to themselves. Where these difficulties are exceptionally great the cure must lie in releasing and bringing under control the energies that determine them, a matter involving a special and highly skilled medical technique. In these pages the attempt has been made to show some of the ways in which a healthy environment, both social and material, may lessen the chances of their arising.

IV—BIRTH-CONTROL

THE object of birth-control is to permit normal sexual relations in marriage without the risk of an unwanted pregnancy. It aims at perventing conception—the union of the sperm cell of the father with the ovum (egg) of the mother—and the various chemical and mechanical agents used for this purpose are known as contraceptives. There is no *absolutely* reliable method of birth-control, but medically approved modern methods are almost certainly harmless, and are reasonably reliable when properly carried out. It must be emphasized, however, that each case should be considered individually by a doctor, who will select the most suitable method and who will instruct the patient in the correct use of that method. A method which is suitable in one case may be quite useless or harmful in another, and a medical examination is essential for determining the correct type and size of any contraceptive appliance. Many wives have discovered, at the cost of an unwanted pregnancy, that it is quite futile to buy appliances from chemists or 'rubber shops,' or by post from the manufacturers on their recommendation. Advertisements of contraceptives usually make unjustifiable claims for the success and suitability of the advertiser's own particular products, and it is unwise to use either a soluble chemical contraceptive or a mechanical appliance except on the advice of a doctor. If the particular contraceptive is advertised as being *absolutely* reliable, or the *only* reliable product of its kind, there is all the more reason to distrust it. There have been failures with every known kind of contraceptive. For anything like a 99% prospect of success with an assurance of harmlessness, the contraceptive method adopted should be prescribed by a properly qualified doctor, who is experienced in the technique of contraception.

Some people confuse birth-control with abortion. Birth-control aims at the prevention of creating a new life; abortion, on the other hand, is the destruction of life. It is well known by doctors, nurses, midwives, and social workers that attempts to procure abortion, successful and unsuccessful, are tragically common, especially in the overcrowded homes of the poor. Desperate mothers risk serious damage to health, and even death, not once, but many times, in their determined efforts to prevent an increase in their family. Abortion, except when carried out by qualified doctors for medical reasons, is a criminal offence: the operation requires the same care and skill as any other abdominal operation. Yet these poor women, when their own attempts have failed, sometimes cripple themselves financially to pay the fee of some

unqualified illegal abortionist who is no more skilled to perform such a delicate and dangerous operation than is a travelling tinker. Birth-control, properly practised, offers a harmless alternative to the illegal, harmful, and dangerous practice of abortion.

The size of the present-day family of the middle and upper classes, compared with that of the families of Victorian times, shows that birth-control is now widely practised by these classes. It is but social justice that a knowledge of proper methods of birth-control shall be made equally available for the poor, among whom there is the greater need for the limitation of their families. Birth-control should not mean a childless home except in those cases in which, for medical or economic reasons, the birth of children would be unjustified. The ideal family will, of course, vary with the health of the parents and the economic conditions of the home. If the race is not to suffer, healthy parents of good stock should have as many children as they are able to maintain properly, without sacrificing the health of the mother. Birth-control will, even in these cases, be advisable in order to space the births of the children, and to permit normal sex relations when the family has been completed.

There are various medical reasons why, in some cases, pregnancy should be postponed, either temporarily or permanently. These include hereditary mental or physical disease in the family of husband or wife; such diseases as insanity, mental defectiveness, epilepsy, and tuberculosis in either partner, and in the wife certain diseases of the heart and kidneys, cancer, diabetes, and exophthalmic goitre. Such physical deformities as hare-lip, cleft palate, and club-foot are known to be hereditary. It is well to discuss the matter with the family doctor before deciding that, for medical reasons, parenthood must be postponed or permanently avoided. Modern medical science can now do a great deal to overcome physical difficulties which in former generations made a difficult labour inevitable or even endangered the life of mother and child. In many cases abnormal smallness of the bony part of the birth canal can now be overcome by inducing labour before full term, so that the baby's head during birth is smaller and softer and more easily moulded; or by performing the operation of Caesarean section, by means of which the baby is removed through an incision of the abdominal wall. A denial of parenthood can be a real tragedy, and may even wreck a marriage; it should not be accepted without very full investigation of the circumstances by a doctor.

For the intelligent adoption of any method of birth-control, it is well to understand clearly the problem involved. To under-estimate the difficulties may lead to failure through carelessness or inattention to detail. There is no foolproof reliable method of preventing pregnancy; forethought, self-sacrifice, and willingness to take trouble, are essential.

Let us first consider briefly the conditions essential for conception. Conception occurs when one of the millions of sperm-cells in the semen (the fluid ejaculated by the husband at the moment of orgasm) succeeds in coming into contact with the ovum (egg-cell) in the tube leading from the ovary to the womb. Normally, one ovum is released from one of the ovaries once a month, and this cell remains alive and capable of being fertilized only for a short time—possibly several hours, and certainly not more than a few days. It is obvious, then, that conception can occur only during the period when the living ovum is present in the tube, and that coitus at other times cannot result in pregnancy. If we knew definitely the times when the ovum is present in the tube, and how long the sperm-cells of the husband can remain alive within the genital tract of the wife, we should be able to calculate with certainty the period during the menstrual cycle when conception is impossible. Restriction of intercourse to this period would then be a reliable method of birth-control. That there is such a 'safe period' in the case of every woman is undoubted; but the fact remains that we cannot at present define this period with certainty. The sperm-cells deposited within the vagina have the power of independent movement: they can swim along the moist lining of the female genital passages, and they are attracted towards the tubes leading from the womb to the ovaries. The womb opens into the upper end of the vagina, and once any sperms succeed in penetrating this opening they are secure from the action of any contraceptives within the vagina. It must be emphasized that the sperms can remain alive and almost certainly retain their power of movement for some hours within the vagina when the conditions are favourable. Any method of birth-control which—as it should—permits normal coitus, with ejaculation of semen before withdrawal of the penis from the vagina, must aim at preventing the sperms from entering the womb, and subsequently at destroying or removing the sperms. The most reliable methods of birth-control therefore combine the use of a mechanical appliance to prevent contact of the semen with the neck of the womb, and a chemical to destroy or immobilize the sperm-cells. If any semen containing living motile sperms remains within the vagina after the mechanical obstacle has been removed, then conception may result if even one of the sperms consequently succeeds in entering the womb.

Harmful and Unreliable Methods of Contraception

Some methods of birth-control are to be condemned because they are unreliable, or harmful, or both: and certain popular ideas of 'safe periods' lead to unwanted pregnancies. Such methods and ideas include the following:

(*a*) '*Withdrawal*' (*coitus interruptus*), known popularly as 'being careful.' This is unsatisfactory for two reasons: its unreliability, and its possible harmfulness. It is probably the least reliable method of all, since recent investigations of many hundreds of cases have revealed that large families are produced in spite of 'withdrawal' on each occasion of intercourse. Even if the husband succeeds in removing the penis from the vagina before the ejaculation of semen, there is yet some danger of an unwanted pregnancy owing to the possible presence of some sperms in the moisture which is produced from the penis before ejaculation, moisture which may be present before penetration. Moreover, the regular use of this method, over a period, may produce definite mental and physical injury. If the husband cannot delay withdrawal until his wife has reached her climax (orgasm), she is left tense and unsatisfied, and this may lead to insomnia, mental depression, 'nerviness,' and dislike of the sex relationship if the unnatural strain is frequently repeated. In addition, she may develop certain physical symptoms as a result of the repeated prolonged congestion of her sex organs. The effects on the husband vary. Undoubtedly there are men who practice 'withdrawal' with no apparent ill-effects, but in the majority of cases neurasthenic symptoms develop sooner or later. The husband may lose his self-confidence, become worried over trifles, and develop a state of anxiety so that he broods over possible calamities, and even dreads the postman's knock. He, too, may become afflicted with sleeplessness and irritability. Opinions as to the harmfulness or harmlessness of *coitus interruptus*, however, vary widely.

(*b*) *Lactation.* The activity of the breast glands in producing milk is popularly believed to prevent conception, and many of those who regard the period when the baby is on the breast as free from the risk of conception and consequently neglect to practise birth-control during this time find at the cost of another pregnancy that a woman may become pregnant while she is breast-feeding, even though she has not yet resumed menstruation.

(*c*) *The so-called 'safe period.'* Reliance on the 'safe period' has proved in practice most unreliable; but many 'failures' may be due to the popularly held but erroneous idea that the mid-menstrual fortnight is the sterile period. For those women with a regular twenty-eight day menstrual cycle, the period when they are least likely to conceive is during the ten days immediately preceeding a menstrual period. Only experience can prove whether this period is indeed absolutely sterile in any particular case, and the price of the experience may be an unwanted pregnancy. Records show that conception has occurred at all stages of the menstrual cycle. There is no way at present known of determining an absolute safe period in any particular case, except, of course, the impracticable one of trial.

(*d*) *Appliances which penetrate into the neck of the womb or which are placed completely within the cavity of the womb.* These mechanical contraceptives are, in the opinion of the writer, exceedingly dangerous, and the use of such appliances should be avoided. Examples of these pernicious contraceptives are the 'wish-bone' gold stem pessary, which is placed in the upper end of the vagina with the stem penetrating the neck of the womb and is left in position for months at a time; and the silver ring, which is actually inserted into the cavity of the womb and left in position for a year or longer. Serious infections causing inflammation of the womb and surrounding structures have resulted from the use of such appliances, and operative treatment including removal of the womb and tubes have become necessary in some cases. No mechanical appliance, even when it does not penetrate the neck of the womb, should be left in position for longer than about twelve hours.

(*e*) *'Holding back,' or the effort to prevent orgasm by the wife.* Some wives lead a mutilated sex life because of the erroneous idea that orgasm in the wife is essential for conception. Such an idea is quite untrue. Some very fertile women, who have had large families, have rarely or never experienced orgasm.

Classification of Methods

Methods of birth-control which are medically approved when used in suitable cases can be classified as follows:

(1) *Used by the husband.*

The *sheath* or *condom*, known popularly as the 'French letter.' This is worn over the penis during sexual intercourse to prevent escape of semen into the vagina.

(2) *Used by the wife.*

Mechanical appliances: *rubber pessaries, sponges, and plugs.* These cover the neck of the womb, and their object is to block the opening into the womb and so to prevent the entry of sperms.

Chemicals: *suppositories* (soluble pessaries), *tablets, jellies, and medicated douches.* These are used to destroy the sperms which have been deposited within the vagina. They should be used in combination with a mechanical barrier, so that when the latter is removed and the entrance to the womb is thus uncovered, there shall be no living sperms left within the vagina.

THE MALE SHEATH OR CONDOM.

When properly used this is one of the most reliable of contraceptives, and is perfectly harmless. The popular notion that it may cause 'consumption' or 'nervous diseases' in the husband is quite untrue.

The use of the sheath is the ideal method during the honeymoon and early weeks of marriage. There are two kinds of sheaths—those to be used once only and then thrown away, and washable sheaths that may be used several times. Rubber, of which most sheaths are made, tends to perish even when not in use, and it is therefore important that *a sheath should be tested before use.* To test a sheath it should be unrolled, and then inflated by blowing into it; or be partly filled with water and compressed from above. The presence of even a tiny hole can thus be detected; and it must be remembered that a hole so small as to admit only the point of a needle may allow exit to several thousands of sperms. Some manufacturers of sheaths are now dating their products, as a means of ensuring that old stock, the defects of which may not be apparent before use, shall not be sold. Most sheaths are sold rolled in readiness for use; when about to be used, they should be unrolled and tested, and then re-rolled. They are adjusted by unrolling them over the erect penis—they should never be drawn on as one draws on the finger of a glove. It is advisable, especially during the early days of marriage, or if the vagina is abnormally dry, that after the sheath is adjusted its outer surface should be lubricated with a special jelly. The best lubricants for this purpose are those which also destroy any sperms with which they may come into contact. Vaseline should not be used for lubricating a washable sheath, as vaseline and all other fatty substances have an injurious effect on rubber. A washable sheath should be examined for defects immediately after use; if it is found to be torn the wife should douche as soon as possible with about a quart of warm water containing four tablespoonfuls of vinegar, or with the same quantity of warm soapy water (a heaped tablespoonful of 'Lux' to the quart makes a suitable solution), or with plain warm water if neither of the above is available. While the douche is being prepared the presence in the vagina of a chemical contraceptive, such as one of the cocoa-butter or gelatine pessaries, or a foam tablet, or a contraceptive jelly, will greatly increase the chance of success in the prevention of conception. If such a chemical is not used in conjunction with the sheath as a routine, it should be available to be inserted immediately a defect in a sheath is discovered after coitus. If the sheath is to be preserved for future use, it should be washed, thoroughly dried, and powdered with French chalk (which can be bought from a chemist); or it can be kept in water. It is best kept flat, and not rolled until immediately before use.

A consideration of some of the causes of the failure of sheaths will emphasize the need for special precautions. Some of the causes are:

(1) The use of a defective sheath. A perished sheath may tear during use, although the defect was not apparent on testing before use. It is important, therefore, that sheaths should be bought from

a reliable source, and preferable that they should be dated by the manufacturers.

(2) Delay in adjusting the sheath until just before emission of semen. Sperms may be present in the moisture which is present on the penis from the commencement of coitus, and may succeed in entering the womb and fertilizing an ovum.

(3) A second coitus without the protection of a sheath, even if withdrawal is intended. Sperms from the first emission of semen may be present on the penis, and thus may be introduced into the vagina.

(4) Delay in withdrawing the penis from the vagina until after the erection has subsided. When the penis shrinks to its normal size the semen may ooze from the base of the sheath on to the lower part of the vagina.

There are some men to whom the sheath is useless; they lose their erection when they attempt to adjust it. Some women object to the use of a sheath on account of the smell of the rubber, or because it causes soreness of the vagina. The latter trouble is due to abnormal dryness of the vagina, aggravated by the absence of the lubricating moisture from the penis; it can usually be overcome by the use of a lubricating jelly. Finally, where for any reason it is desirable that the means of prevention of pregnancy should be in the hands of the wife, the use of a sheath is contra-indicated.

The sheath is particularly suitable in cases of premature ejaculation, in which emission of semen occurs almost at once after penetration. This is known popularly as 'being too quick.' The use of a sheath in such cases diminishes sensation, and may thus assist very much in the effort to delay ejaculation in order to permit normal coitus to take place. For use at the consummation of marriage and for the first three or four weeks of marriage, when the vagina is not sufficiently stretched for the satisfactory use of a mechanical appliance, the sheath is the method of choice.

MECHANICAL APPLIANCES.

Rubber Occlusive Pessaries. Rubber pessaries used to shut off the neck of the womb from contact with the semen are of various types and of several sizes. The correct use of any of these demands that in the first case it should be selected, both for type and size, by a doctor who examines the patient. An appliance which is quite harmless and suitable for one patient may be quite unreliable and harmful for another whose internal sex organs are of different size or shape and condition. Moreover, the most suitable type of appliance may be quite useless if not correctly used; the patient should therefore be taught how to adjust and remove it.

It must be emphasized that, since rubber occlusive pessaries—unlike the sheath—allow the semen to be deposited within the vagina and in contact with its surface, a rubber pessary used alone does not give adequate protection. When the pessary is removed living sperms may be present, and may then find their way along the vagina into the womb. A chemical contraceptive should therefore be used (suppository, jelly, tablet, or medicated douche) in conjunction with the rubber appliance. As fatty substances, such as cocoa-butter, vaseline, etc., have an injurious action on rubber, chemicals containing these substances should not be used with rubber pessaries.

There are three main types of rubber pessary now advocated by doctors.

(1) *The Dutch or Diaphragm Pessary.* This is the largest of the occlusive pessaries, and fits diagonally across the vagina, shutting off the upper part of the vagina—including the neck of the womb—and most of the front wall. As it is made in about twenty different sizes, the reader will appreciate that the fit of this pessary is of great importance. The sizes vary only by two and a half millimetres in diameter. The pessary has a flexible rim of watch-spring or coiled wire, which encloses the thin rubber diaphragm or shallow sac. Just before insertion the pessary is smeared all over with a contraceptive jelly or ointment. It may be put into the vagina any time during the evening, before intercourse; and as when properly adjusted and of the correct size its presence in the vagina is not perceptible to the wearer, it does not interfere with the spontaneity of intercourse. It should never be left in position for longer than twelve hours. Usually, therefore, it is adjusted some time before retiring to bed, in the evening, and removed the following morning, before or after breakfast, as is most convenient.

Now comes the choice of a chemical contraceptive to be used in conjunction with the Dutch pessary. There are gelatine suppositories, small tablets, which, on melting, form a foam, jellies, and foaming jellies; either of these must be inserted into the vagina before intercourse, according to directions, and after the rubber pessary is in place. The drawback to the use of these preparations is the need of inserting them just before intercourse; and some women object to this interference with the spontaneity of intercourse, and dislike the manipulations involved. They would therefore probably prefer the chemical douche, used the following morning when the pessary is to be removed. About a quart of douching solution is used, and the rubber pessary is removed midway in the douching process; that is to say, the vagina is first washed out, the neck of the womb is uncovered by removing the pessary, and then a final irrigation of the vagina completes the process. The pessary should be washed in warm soapy water, rinsed, and then thoroughly dried and powdered with French chalk. It should be

stored when not in use in a box or tin with a close-fitting lid, and kept in a cool dark place.

The actual instruction in adjusting and removing the pessary should be given by a doctor or nurse or midwife who is trained to give this instruction. The actual choice of the size of pessary should always in the first place be made by a doctor, since there may be conditions present, conditions recognizable only to a medically educated person, which make the use of this type of pessary—or of any other type—inadvisable. When the correct size is selected, however, any trained person can give instruction in the use of the pessary.

The patient to be instructed will first be taught to examine herself by inserting her finger into her vagina, and exploring the size and shape of this cavity. The main object of this is that she may feel and identify the projection at the upper end (the cervix)—a fleshy lump in consistence rather like the tip of the nose—which is the neck of the womb. She should be made to understand that unless this projection is covered by the rubber pessary, she is in no way protected against conception. It is possible to place pessaries in the vagina without covering the neck of the womb; and this is undoubtedly the cause of some of the failures in the use of the appliance. Fortunately, the thinness and looseness of the rubber diaphragm enables the neck of the womb to be felt quite clearly by the finger when the pessary is properly adjusted; the patient can thus check the correct position of the pessary by feeling for the cervix through the rubber diaphragm which covers it. The position which is most commonly found best for these manipulations is the squatting position, but each woman will find by experience which position is most comfortable to her.

The pessary, lubricated with the jelly or ointment, is held with the rim compressed between thumb and fingers of the right hand (or left hand if the patient is left-handed), so that the circular rim becomes flattened and elongated. It would not be possible to insert the pessary through the opening of the vagina in its original circular shape; but as the rim is flexible it can be flattened sufficiently for the purpose. The pessary is then pushed into the vagina so that the part which first enters passes along the back wall of the passage and behind the neck of the womb, and the final part of the rim to enter is tucked just under the pubic bone in front. The pessary is placed with the dome uppermost, so that when the projecting womb pushes the rubber diaphragm downwards, a shallow gutter is formed between the rim and the cap. This gutter is most useful when removing the cap, as the tip of a finger can easily be pushed into it to get sufficient purchase on the rim to pull out the pessary. If the pessary is put in the other way up—concavity uppermost—the patient will appreciate how much more difficult it is to remove it, as the finger must then be forced round and over the rim

in order to get a grip of it. After removal the rim of the pessary should be gently remoulded between thumb and fingers to restore its original circular shape.

Suitable lubricants for the pessary are:
'G.P.' Ointment or Jelly (Gilmont Products Ltd.).
'Contraceptaline' (Lamberts Prorace Ltd.).
'Milsan' jelly (Menosine Ltd.).
Soapy water (preferable if a foam tablet is to be used).

Spermicidal lubricants usually contain chinosol or quinine; their reliability is usually doubtful.

(2) *The Dumas Pessary*. This pessary is shaped like a shallow bowl, and is made entirely of rubber, the thickened edge giving it sufficient rigidity. It fits close up to the upper end of the vagina, and thus covers the neck of the womb. Unlike the third type of pessary to be described the Dumas pessary does not fit on to the neck of the womb. This pessary is made in three sizes only, and is usually advised in those cases in which there is not proper support for the rim of the Dutch pessary, as when the vagina has been badly stretched after the birth of several children, or when there is not sufficient space behind the pubic bone in front to support the rim of the Dutch pessary. The Dumas pessary is compressed between the thumb and fingers, and inserted into the vagina with the dome downwards. As soon as it has entered the vagina, it is allowed to open out and is pushed to the extreme end of the passage, so that the neck of the womb lies in its concavity and the edge of the pessary is in contact with the top of the passage. It is not so easy to remove as the Dutch pessary, because the finger must reach to the upper end of the vagina in order to hook over the edge of the pessary and pull it out. When the pessary is in position the neck of the womb cannot be felt through the thick rubber; the finger must be pushed over the edge of the tilted cap to make sure that the neck of the womb is covered by feeling this projection within the pessary. After checking its position in this way the tilted pessary should be firmly pressed back into position. This type of pessary should not be used if the neck of the womb has been badly torn during child-birth, or if there is a copious vaginal discharge; and in any case, it should never be left in position for longer than twelve hours. As in the case of the Dutch pessary it should be lubricated with a contraceptive ointment or jelly or with soapy water, and a chemical spermicide or a douche should be used also.

(3) *The Cervical Cap* ('Prorace,' 'Racial,' and other models) is the smallest of the rubber pessaries. It is made in four sizes, and in shape resembles a thimble. It is designed to fit on to the neck of the womb (cervix). It is adjusted in the same way that the Dumas is adjusted, and like all other rubber pessaries, it requires a lubricant and should

be used only in conjunction with a chemical contraceptive. It should never be used if the neck of the womb is torn or unhealthy, or in the presence of a discharge. It is particularly important that this type of pessary should be used only on the advice of a doctor and that the correct size should be selected by a doctor. If the pessary is too small or the dome too shallow, serious injury may result. Some doctors disapprove of this type of pessary in any case because they fear the possibility of setting up a chronic inflammation of the womb, and for other reasons which do not apply to the two other forms of rubber pessary described above. It is most important, then, that the cervical-cap type of pessary should never be used without the sanction of a doctor, and that the usual precaution of not leaving it in position for longer than twelve hours should be observed. If after removal the cap is found to be filled with discharge the writer believes that its use should be discontinued, and some other type of pessary or some other method of contraception substituted. This pessary is inserted in the same manner as is the Dumas, and is pushed on to the neck of the womb, which can be easily felt through the thin rubber dome.

After use all rubber pessaries should be washed, dried, and powdered with French chalk, and kept in a box or tin, with a close-fitting lid.

The final test of the suitability of any rubber appliance comes when it is actually in use during sexual intercourse. If the patient or her husband is conscious of any discomfort due to the presence of the appliance, or of any lessening of sexual satisfaction; if the appliance is dislodged during intercourse; or if on removal it is found to contain much discharge or any trace of blood, the doctor should be informed so that he may consider the advisability of prescribing some other method of contraception. Moreover, some medical treatment may be indicated, as a vaginal discharge (other than a slight amount of whitish discharge just before and after menstruation) or any bleeding at all (except during menstruation) is not normal; either indicates a need for medical investigation and treatment.

In the course of time any appliance, which was quite suitable and harmless when prescribed, may become unsuitable owing to changes in the condition of the womb and vagina. It is advisable, therefore, to keep in touch with the doctor, and to have a routine examination at intervals of six months or a year, in case it becomes advisable to change the size or the type of appliance.

Sponges. The woman who is unable to consult a doctor for the choice and fitting of a rubber occlusive pessary, or who cannot use such a pessary because she wears a ring to support a prolapsed womb, or who on examination proves to be unsuitable for such an appliance, may be advised to use a sponge as a mechanical contraceptive. The small round natural sponges which are still being sold for birth-control are

in most cases quite useless; during intercourse they are easily pushed aside, leaving the neck of the womb exposed. The best type of sponge, such as the 'Racial,' is a flattened disk-shaped soft rubber sponge, sufficiently large to cover the whole of the roof of the vagina, and about an inch thick. Such a contraceptive sponge can be cut from an ordinary rubber sponge, and there is no need for an enclosing net and string attachment if the patient can remove the sponge from her vagina by hooking her finger over its edge and getting sufficient purchase to pull it out. When it is about to be inserted, the sponge should be soaked in some contraceptive fluid (such as olive oil, soapy water, or equal quantities of vinegar and water). The second line of defence should be a chemical contraceptive (suppository, tablet, or jelly), or a douche used the following morning when the sponge is removed. After use, the sponge should be washed in warm soapy water, thoroughly rinsed, and either kept in a solution containing disinfectant or else dried. Occasionally it should be boiled for a minute.

Vaginal Plugs. A pad of cotton wool or gauze or fine butter muslin, sufficiently large to spread over the whole extent of the upper part of the vagina, can be used as an emergency measure, and is particularly useful for women in outlandish parts of the world who are not in touch with a doctor. The pad should be soaked in lemon juice or in vinegar and water (equal parts), and smeared with vaseline or contraceptive jelly. The pad should be removed the following morning after intercourse, and discarded; a new pad should be used for each occasion. If there is any difficulty in removing the pad a thread attachment can be tied to it, long enough to protrude from the vagina when the pad is in position. By pulling on this thread the pad can then be easily removed. If cotton-wool is used it is a good plan to enclose the pad with a covering of thin, open-meshed gauze. After the pad is adjusted additional security is achieved by inserting a chemical contraceptive. Since rubber is not used, the cocoa-butter suppositories are quite suitable in this case. A douche of vinegar and water or lemon juice and water (two tablespoonfuls to the quart in each case) or of plain warm water, will give still further security.

THE DOUCHE.

The douche, which combines a chemical and a mechanical contraceptive action, should be used only in conjunction with some appliance which covers the neck of the womb. If the semen is ejaculated on the neck of the womb sperms may succeed in entering the womb almost immediately, in which case they are quite unaffected by subsequent douching, even though the douching be carried out immediately after intercourse. There are reasons, too, why it is most unwise to rise and prepare and administer a douche immediately after intercourse, for this

is the time when there should be absolute rest and repose, culminating in normal sleep.

It should be clearly understood that a daily douche (except when a medicated douche is ordered by a doctor as treatment for a diseased condition) is most unwise and may be dangerous. The healthy vagina does not need a daily irrigation; and too frequent washing away of the natural protective secretions may pave the way for an acute inflammation. For contraceptive purposes, where besides killing and removing any living sperms that still remain it is desirable to wash away the residue of any chemical preparations that have been used, douching twice a week is harmless and advantageous.

Contraceptive douching is advised:

(*a*) In conjunction with a rubber pessary, sponge, or vaginal plug, when it should be deferred until the morning after intercourse; and

(*b*) as an emergency measure when a sheath has torn during intercourse. The douche should then be used as soon as possible after intercourse; and a soluble suppository or tablet, or a jelly, should be inserted into the vagina at once so that it may afford some protection while the douche is being prepared.

Method of Douching. The irrigation of the vagina can be carried out by means of a whirling spray, an enema syringe (using the vaginal nozzle supplied), or a douche can or bag with tube and nozzle. For the early days of marriage, when the opening of the vagina may still be very small, the enema syringe or douche can is most suitable, as the nozzle of the whirling spray is sometimes too thick in such cases.

To be really effective the douching solution should not merely trickle in and out of the vagina. The lining of this passage is not quite smooth; it is thrown up into folds with intervening depressions; it is also very elastic. It is advisable that the passage should be slightly distended by the solution so that it may come into contact with all parts of the surface. Unless the woman douches while she is lying down (as when using the douche can and tubing), in which case sufficient distension is probably achieved owing to her position, she should make use of the collar or flange supplied with the whirling spray or enema syringe, or should compress the lips of the vulva with her fingers around the base of the nozzle, and allow the douching fluid to escape in gushes and not to trickle away continuously. The flange supplied should be adjusted at the base of the syringe nozzle and pressed close to the vulva to control the outflow in the manner desired. The distension of the vagina should be such that there is no discomfort from the pressure. With this precaution there is no possible danger of forcing the solution into the womb. Douching can then be carried out in a sitting or crouching position. After use the nozzle should be thoroughly cleansed in plain warm water.

Douching Solutions. The douche should always be warm, at about body heat. It is dangerous to use a cold solution.

Plain warm water is known to immobilize and probably to kill sperms quite quickly, and therefore a plain douche of warm water is probably quite efficacious. Most women prefer, however, to use a medicated douche because of the greater feeling of security it gives. The following substances, *dissolved in a quart of warm water*, are suitable:

Soap. Two level tablespoonfuls of 'Lux' or a piece of pure superfatted toilet soap of a size equivalent to two large cubes of sugar. The soap must be thoroughly mixed to form an emulsion. Cheap soap flakes or strong household soaps should not be used on account of the excess of soda, which may prove irritating.

Lemon Juice. Two tablespoonfuls.

Vinegar. Two tablespoonfuls.

Lactic acid. One teaspoonful. This is a clear fluid which may be obtained from any chemist.

CHEMICAL CONTRACEPTIVES.

There are many chemical contraceptives on the market, some of which are advertised with unjustifiable claims of complete reliability even when used alone, without the additional protection of a rubber appliance. The writer has known every type of chemical contraceptive, when used alone, to fail. It should be realized that manufacturers who are anxious to promote the sale of their particular product are apt to be unduly optimistic or even unscrupulous in claiming success. Some products are much better than others, and it is well to take the advice of a doctor in the choice of the most suitable chemical contraceptive in any particular case. The doctor takes into consideration such things as cost, the frequency of use, and any special factor such as residence in a tropical climate.

The essential constituent of a chemical contraceptive is a substance which will rapidly kill or render motionless the sperm-cells in the semen, so as to prevent them from making their way into the womb. This is combined with other substances to give suitable bulk and consistency. The proper function of a chemical contraceptive is use in conjunction with a rubber vaginal pessary or a sheath. If the sheath were untearable there would be no need for the chemical; the presence of the chemical is some protection against pregnancy should the sheath be defective and so allow sperms to enter the vagina. When a rubber vaginal pessary, such as the Dutch cap, is used, the whole of the semen, containing millions of living sperms, is deposited within the vagina; the object of the chemical contraceptive is to kill or immobilize these sperms before the rubber cap is removed. In women of low fertility, or if intercourse is restricted to the relatively safe period, a chemical

contraceptive alone may prove efficacious. It should be clearly understood, however, that if the greatest possible protection against pregnancy be desired it is essential to use a mechanical barrier in addition to the chemical.

Types of Chemical Contraceptives.

(*a*) *Soluble Suppositories* (*pessaries*), in which the chemical contraceptive is incorporated in a base of cocoa-butter or gelatine, melt at body temperature. Since cocoa-butter injures rubber, gelatine should be selected for habitual use in conjunction with a rubber appliance. Odourless or scented cocoa-butter suppositories are now available.

(*b*) *Soluble Tablets* (*'foam tablets'*), which dissolve in the vaginal fluids to form a foam. It facilitates solution if these tablets are moistened in water—preferably warm water—immediately before insertion. Most of the manufacturers advise that the tablet be inserted about six minutes before intercourse. In fact, the time required for solution depends largely upon the amount and character of the vaginal fluids, and in many cases a considerably longer time is required. In some cases the tablets fail to dissolve at all. These tablets should never be used during the honeymoon, as contact with abrasions caused during the consummation of the marriage may cause intense smarting.

(*c*) *Jellies* (*foaming and non-foaming*) have the advantage that they are effective from the moment of insertion; no time is required for solution, and they are not dependent upon the vaginal fluids.

(*d*) *The Douche* containing vinegar or lemon juice is a chemical contraceptive, since the solution kills or immobilizes the sperms besides washing out the vagina.

Method of Use. When the chemical suppository, tablet, or jelly is used in conjunction with a rubber pessary, it may in each case be inserted after the rubber appliance is in position. The rubber cap may be adjusted an hour or two before retiring, so that there is the least possible interference with the spontaneity of intercourse. Some doctors, however, advise that the chemical be placed above the rubber cap. Where the former method is employed, the patient should remain in the lying-down position so as to prevent the dissolved chemical substance from flowing out of the vagina before intercourse. The suppository or tablet will not be effective unless it dissolves completely before intercourse takes place. Some patients are unusually affected by certain chemicals; and a suppository, tablet, or jelly which is used with perfect comfort by one woman may cause irritation or smarting of the vagina in another case, and may therefore have to be discarded. There are a large number of effective preparations from which to choose, and prices vary from two shillings to ten shillings a dozen. The doctor's advice should be sought regarding the most suitable preparation in any particular case.

General Advice

Birth-control is a medical matter, therefore a doctor's advice and instruction should be sought. It may become necessary to change the method in use, according to special circumstances. For instance, during travel or holidays, the douche may be inconvenient and, therefore, a soluble suppository or tablet or a jelly should be substituted. After childbirth, or within six months of marriage, or at other times, a change in the type or size of rubber pessary may be advisable.

By the wise and moderate use of birth-control, parenthood can be properly planned with due consideration for the health of the mother and the welfare of the family, and at the same time the normal sexual needs of husband and wife can be met. As in the case of all the benefits of humanity resulting from scientific knowledge, birth-control can be abused, just as food is abused when people overeat, or as games and sport are abused by immoderation. To say that it is 'unnatural' is saying nothing; it is unnatural to seek medical aid for sickness, to wear clothes or eyeglasses or false teeth; indeed, most of the benefits of civilization are unnatural. What does concern us is that the method of birth-control selected shall be medically approved as reliable, harmless, and suitable for the particular case.

V—MIDDLE AGE

One is apt to think of the seven ages of man as if their divisions were water-tight compartments. A much more correct view of the matter is expressed in the saying that the child is father of the man. But even this does not sufficiently emphasize the influence that each stage exercises upon the succeeding stages, and the indelible mark which environment leaves on each. A person at any given stage may truly be said to be the resultant of the conditions of his past life. This is to be borne in mind at every stage, but its truth becomes increasingly impressive as the years pass by, from the age of forty-five onwards. It is at this period, the meridian of life, that the seeds sown in childhood, youth and maturity are coming to florescence and fruition, and a wise man is therefore moved to pause and take stock of his physiological position. As a piece of animal mechanism he has waxed and waxed; soon he will begin to wane; it is for him to make the intervening period as long as possible and as fruitful as possible; how is he to do it? The answer to this question is comprised in the word moderation. He must not on the one hand resign himself prematurely to the results of time, nor must he on the other seek to decorate the period of full maturity with the trappings proper to youth. He must neither loll in a Bath chair, nor captain a football team. 'Discern of the coming on of years,' says Bacon, 'and think not to do the same things still, for age will not be defied.' This refers more particularly to the purely physical side of life; in the sphere of the intellect there ought to be no sensible decline until a much later period; it is indeed the case that many men have shown themselves mentally at their best when well passed the Psalmist's threescore years and ten. In the matter of the intellect, Martin Luther's rule should be the guide: 'If I rest, I rust.'

Exercise

In taking stock of the physical position he will, if he is honest with himself, find a good deal that wants altering, much that requires checking, and still more that demands uprooting. It is for example a well observed fact that men who have been athletes in the days of their muscular prime, have acquired at that time the, perhaps justifiable, habit of large meals, and that the habit has continued long after the athletic justification has ceased to operate. Most athletes are obliged sooner or later to relinquish their outdoor activities in order to engage

in the serious business of life. Their lessened muscular output should lead to a very much diminished alimentary intake both in quality and quantity. But this very seldom happens at first. When it is brought home to a man with any physical self-respect that his lessened muscular expenditure, together with his sustained alimentary intake, are leading to abdominal obesity and to breathlessness on moderate exertion, he realizes that an effort to redress the balance is now called for, and he makes his dispositions accordingly. Many a man, when rallied on the question of his figure, will protest that there cannot be much the matter because his weight at his athletic best was the same as it is to-day, in his athletic gloaming. Upon which the obvious, if brutal, retort must be that in the old days the weight connoted hard muscle carried in the appropriate places on his limbs, whereas the weight to-day means soft, almost semi-fluid fat, which protrudes in unsuitable convexities about his trunk.

In discussing the question of weight, especially of increasing weight, nine Englishmen out of ten will express themselves in terms of exercise. And yet, as a scientific fact, exercise has much less to say in the matter than is generally supposed. This, to the astonishment of most people, has been shown by a Chicago physiologist. He set himself to determine the amount of exercise necessary to remove one pound of fat from a fairly healthy body, and concluded as follows: 'In order to wear off a single pound of fat by exercise, the average sized individual must either fence eight hours, wrestle five and a half hours, walk one hundred and forty-four miles at the rate of two miles an hour, or play football hard for four and four-fifth hours.' . . . It is not difficult to see in such experiments a sufficiently large margin of error to invalidate any dogmatic inference, but there is enough of point in them to show that the prime importance hitherto attributed to exercise in the reduction of weight must undergo serious revision. Yet some observers hold that exercise has a great influence in the reduction of size. Du Bois, for example, says that a decrease in activity comparable to the walking of a mile and a half a day might result in the deposition of a third of an ounce a day or about eight pounds in a year. After all, overweight is not a disease, it is merely an indication that the physiological balance is upset, and as it is a sign which he who runs may read, it is often regarded as the most important, merely because most obvious, of many pointing in the same direction. There are certain tables published on penny-in-the-slot machines and elsewhere which give approximately correct weights for height and age. That there should be a sliding scale for height is quite obvious, but there does not seem to be any excuse for the wide differences which these tables permit between the weights of the same individual at different periods of his life. To allow, for example, as most of them do, an increase of a stone (14 lb.)

between the ages of twenty-five and fifty, though doubtless deplorably common in fact, has no excuse in principle. The middle-aged man should not allow himself to be guided by such tables. He is indeed wise if he seeks so to order his way of living as to secure a weight rather under the minimum allowed by the tables. It is a true saying which tells that spareness is a token of long lasting and warns us that fat men don't make old bones. The factor of greatest importance in regulating weight and contour is of course diet. It is the quantity and quality of the food taken which matter most; a question to which we shall return later.

The value of exercise at middle age is not only or indeed chiefly a question of corpulence, it is a question of getting rid of the waste products of tissue change. These waste products, which are toxic, must be so treated that they become harmless, and they are for this reason and to this end burned up in the muscles. This expression is no figure of speech. The material is oxidized in the muscles by the heat generated by their contraction, in exactly the same way that coal is burned in a grate, and unless the fires are kept burning briskly, the waste toxic products are not properly consumed—they are burned to cinder and not to ash—with the result that they tend to accumulate in special situations, and middle-age troubles such as rheumatism, neuralgia, and fibrositis become common. If the intake of food is not diminished and the output in muscular contraction is inadequate, the toxins remain lurking in the tissues and a slow chronic poisoning results.

Cleansing the System

It is important to bear in mind this conception of ordinary more or less healthy living as a state of slow poisoning. It has been said that as soon as a man is born he begins to die. This is in a sense true. He begins to die because he begins to poison himself. At first the poisons which he manufactures in his ordinary physiological processes—feeding, movement, respiration, and the like—are very readily neutralized by the antidotes which Nature provides, but as time goes on the poisons increase both in number and potency, and the antidote factory tends to become exhausted from overwork. If man begins to die at birth, the pace at first is slow; it becomes accelerated as time goes on, until at length the poisons gain the upper hand, and the end comes. The pace at which the slow poisoning proceeds and the form which it takes depend upon many things. The poisons vary with the individual; those which gradually overtake and smother Jack differ from those which stifle Tom and those which afflict Jill. The toxins which thus accumulate, and begin about middle age to make their presence severely

felt, are not only alimentary ones, taken in from outside in ignorance or wantonness; others are manufactured in the system itself.

Every physiological act, however simple, breathing, walking, writing, thinking, necessarily uses up material—burns petrol—and, in the using, creates waste products. There are means for the disposal of these waste products, and in healthy people the work is well done, but if the waste products are in continual excess, the machinery has to be driven at high pressure, and in consequence shows wear and tear sooner than it should. It is wise to look for evidences of such wear and tear in the forty-to-fifty decade we are now considering, in order that any fault may be found and corrected. A good many of these dangerous waste products are, as already explained, rendered harmless by being burned up in the muscles; others undergo a chemical change which transforms a complicated into a simple structure, easy of disposal. The more important of the waste products are, however, passed on to the main excretory organs for expulsion from the body. These organs are the kidneys, the lungs, the skin, and the bowels. Now, about these great organs it is important to remember a very simple fact which is far too often overlooked, namely, that they are banded together in a sort of brotherhood by virtue of which, if one organ is disabled, one or two or all of the others will come to the rescue and try to aid in the excretory work of the disabled or indisposed member. But inasmuch as each is armed and engined to do certain very highly specialized work, its ability to undertake the task of another member while still attending to its own is limited, and is very liable to embarrass the proper performance of its own job.

Keeping the Blood Pure

It is to be remembered that everything that reaches the tissues, whether it be boon or bane, is carried there by the blood. The blood may be very unwilling to carry certain substances, and may do its best to rid itself of harmful material as quickly as possible. But when the harmful material is supplied in small doses at first and later in gradually increasing quantities a tolerance is established, till after a few years the blood will accept an amount of a particular poison which if tendered in the first instance it would have made a vigorous attempt to expel. The repair material destined for the tissues is taken from the digestive tract and added to the circulating blood which delivers it to the appropriate organs. When any particular organ has utilized its share of this material there result certain waste products which it is the duty of the blood to remove and to carry to the agencies which will render them harmless. It is thus not only a purveyor of necessaries, but also a scavenger of refuse, and it is upon the proper performance of this latter

function that the well-being of the individual largely depends. To go without sufficient food is bad, but in the presence of plenty to be clogged up with refuse is infinitely worse.

The necessity for maintaining the blood in a high degree of cleanliness cannot be over-emphasized. The very complexity of composition and extraordinary variety in function of the vital fluid seems in a curious way to mask the fact that all the processes of tissue change, whether in stomach, muscle, bone, or brain, are carried out in a fluid medium. It is difficult to realize that the tough, solid, hefty food which we place in our mouths must be transformed into a fluid nearly resembling milk in appearance and consistency before it can be utilized by the appropriate organs for the repair of waste. And if we try to visualize the amount of energy demanded by the conversion of so much crude solid into the equivalent of bland fluid it becomes easy to understand how such complicated machinery may go wrong. Watching the ways of the majority of people in the matter of food one is surprised, not that the digestive processes occasionally go on strike, but that they do not fail completely more often than they do.

An important implication of these considerations is that people should make a point of taking a sufficiency of fluid to enable the blood to do its work easily. Fluid is normally lost in considerable quantities through all the excretory organs, notably the kidneys, which void from three to four pints daily, lungs which give off a pint, and skin which loses at least a pint by insensible perspiration. This loss should be balanced by a full intake of simple fluid, either water as such, or the fluid present in uncooked fruits and vegetables. Water containing a small quantity of tea or coffee is fairly free from objection, but a fluid such as milk, which is merely a concentrated food in liquid form, has little or no value for the work of flushing and dissolving, which is the process now under consideration. Alcoholic drinks, which are what is called 'food sparers,' even when they are not, as beer is, a true food—though much better than milk for this purpose, are not entirely free from objection. The flushing and solvent duties of the fluid ingested should always be born in mind. The blood and tissues are jealous custodians of their fluid, they will not part with more than a certain proportion of it, so that, unless the supply from outside is liberal, the undischarged fluid is forced to store concentrated toxic material which it would fain carry away. The undoubted efficacy of many 'cures' at health resorts is due mainly to the large quantity of fluid taken in the course of the treatment, and is not, as is often supposed, the result of some special ingredient in the natural mineral water. The spas which are able to show the best results in the rheumatisms and fibrositis and neuralgias of middle age are those which combine baths and physical methods such as massage with the drinking of plenty of

fluid. Of such the best known are Vichy, Aix-les-Bains, Evian, Vittel, and Contrexéville. Some enthusiasts, recognizing the desirability of drinking a fluid with a high solvent power, have taken distilled water by the mouth. This is a mistake. Distilled water is too 'searching'; a fact of which, as has been pointed out, any one may convince himself by putting a drop or two into the eye. The pain, though momentary, is very intense; a reaction which does not ensue when ordinary tap-water is used.

It should thus be obvious that of the means of defence with which we are furnished against the chronic poisoning that is liable to overtake us at the meridian of life, a really active blood-stream, constantly depurated, and reinforced by water, ranks as among the most important. The scavenging work of the blood is not usually given its proper weight; people think only of what is borne in on the stream in the way of repairing material; they rarely consider the dangerous waste products which by this means are busily and carefully removed from the tissues and handed on to the excretory organs for final disposal. An authority has recently told us that 'water is the body's greatest need. To get the maximum nutrition out of solid food water should be taken in small quantities at frequent intervals during a meal. It has been proved by experiment in man and animals that a reasonable dilution of solid food in the stomach makes the food go further. A dietary which, taken without water, will not suffice to maintain the balance of intake and output can be made to do so by adding water to the meals. In the past there has been much discussion as to the proper time for ingesting the all-essential fluid. To take it during a meal, as recommended above, is said to run counter to the lessons to be learned from the lower animals, none of which drink with their meals. It is, moreover, asserted that water taken with a meal dilutes the gastric juices and interferes with digestion. It is nevertheless proper to point out that experience at health resorts and elsewhere has shown that a good time for the drinking of fluids, if these be taken in large quantities, is an hour before the principal meals. Fluid should always be taken deliberately in small mouthfuls at a time, and whenever possible should be immediately followed by a period of complete rest.

The Excretory System

Let us now look at these excretory organs—emunctories, they are called—in a little more detail, always bearing in mind that though there is nothing about these organs which is especially to be feared at the meridian of life, it is at this period that the first signs of wear and tear are liable to show themselves.

The food which is taken into the body and utilized, replaces material

which is worn out, and is consequently not only useless but poisonous. This material, the end-result of tissue change, is voided as urine by the kidneys, via its reservoir, the bladder. The duties with which the kidneys are charged are extremely important. If these organs altogether fail to perform their excretory task, lethal poisons collect in the system, and death is the rapid and inevitable outcome; and even when the failure is but partial, the results are highly dangerous to life. Roughly speaking, the kidneys may be regarded as filters which, while allowing effete matters and other poisons to pass through, ensure the retention of valuable material. Normally, their selective capacity is very keen. They are quick to void undesirable matters and comparatively leisurely in discharging those which, though useless, are harmless. They are very sensitive to various influences, and are called in aid when any of the other excretory organs fail adequately to perform their respective tasks. Thus, they are much more active in cold weather when the loss of water by the skin is reduced. Their activities are very much increased when the bowels are constipated, and when the intestinal glands are lazy in the performance of their antiseptic functions; when, that is, poisons tend to accumulate in the system. Like the bowels, they respond at once to poisons introduced from without, which they do their best to get rid of as soon as possible. Nervous influences of various kinds will produce a very large, in some cases an enormous, outflow of urine. Some diseases, such as diabetes and certain affections of the kidneys themselves, are accompanied by an increased output. In view of these facts it should be recognized that a condition exists which may properly be described as renal diarrhoea, of which people would do well to take cognizance; not, however, as an offence to be corrected, but as a warning to be heeded. Some articles of ordinary food or drink are liable to produce end-results which irritate these delicate organs, and in the absence of any obvious cause for a renal diarrhoea, such substances should be sought for and rigidly excluded from the schedule. As people have curious idiosyncrasies in this respect, it is quite impossible to lay down any rule, but it may be said that such apparently harmless substances as tea, coffee, and some wines, especially champagne, act in this way on many seemingly healthy people.

That large and important organ, the skin, is charged with many duties, but its work as an excretory organ is seldom appreciated as it ought to be. Practical experience teaches us that this large surface, more or less exposed to the air, is capable of doing a vast amount of excretory work which cannot well be performed elsewhere. As in the case of the kidneys, the skin does its work by the medium of water. Apart altogether from the sensible perspiration, to be considered immediately, we have to remember that watery vapour in an insensible form is exhaled from the surface of the skin just as it is

exhaled from the lungs. It is, in fact, evaporated, and the main purpose of this evaporation would seem to be the regulation of the heat of the body. Nor is it only watery vapour which is thus given off. We have little difficulty in convincing ourselves that in actual practice gaseous emanations, sometimes of a very pungent kind, habitually accompany the watery vapour, and there can be no reasonable doubt that these emanations are of such a nature as to render their discharge in the highest degree both physiologically necessary and aesthetically desirable.

Sweating then must be regarded as one of the normal physiological methods of excreting waste products from the system, and should be cultivated as a very easily attainable means towards the maintenance of health in middle age. Inasmuch as the water discharged by this route is liable to be large in quantity, care should be taken to replace it by drinking a sufficient quantity of fluid, otherwise the bowels and kidneys may find themselves deprived of the vehicle essential for their activities. That the skin may be induced to undertake a considerable portion of the excretory work of the kidneys is well known to doctors, who are in the habit of prescribing sweating processes to patients suffering from inefficiency of the kidneys, as in certain forms of Bright's disease. That it may, and frequently does, perform some of the work of the inactive bowel is all too frequently and unpleasantly forced upon the consciousness even of the most unobservant, by the foetid faecal odour which emanates from the skins of usually meat-eating people who lazily allow themselves to be continually constipated.

The air which we inhale is dry. Its dryness depends upon climatic humidity, which varies between, say sixty-five in a dry climate, such as that of Egypt, and eighty-two in a humid climate, such as that of the south-west coast of England. The air which we exhale is entirely saturated with moisture, representing in relation to the above figures the maximum of one hundred. It follows that the greatest amount of water which can be removed from the body by this route will escape during muscular exercise in an atmosphere which is cold and dry. That is the reason why keen, dry air is felt to be invigorating: it invites to muscular exercise. Thus, the lungs excrete water: they also excrete carbonic acid gas. This last is a poison which is manufactured in the tissues, and as voided is at once replaced by oxygen, which is essential to the tissues. The exchange of carbonic acid for oxygen which takes place in the lungs has already been referred to, and certainly constitutes by far the most important function of these two large organs. The bodily system is relatively tolerant of carbonic acid, poison though it really be. It is especially tolerant when the poison is imposed upon it by degrees as, for instance, in crowded assemblies, where it accumulates in the atmosphere bit by bit.

What has been said above concerns pure carbonic acid gas, uncontaminated with the organic vapours which are to be found in air exhaled from ordinary human lungs. The addition of such contamination naturally renders the air containing the carbonic acid even more poisonous, and although it may be true, as authoritatively contended, that apart from its carbonic acid content, the exhaled breath of a perfectly normal person is not toxic, experience would suggest that in this matter there must be very few perfectly normal persons. We are therefore forced to the conclusion that in addition to water and carbonic acid, the lungs are charged—exceptionally perhaps, but still charged—with the duty of excreting certain other substances of a deleterious nature; that they are, in fact, supplementary excretory organs. It is well known that in middle and later life there are such things as gouty bronchitis and gouty asthma, but it is not always realized that the occurrence of these is due in part to an effort on the part of the bronchial tubes to aid in the expulsion of the gouty poisons. There are indeed many whose opinions are justly entitled to respect who hold that bronchitis is always due to a weakening of the bronchial soil by the ceaseless endeavour of gouty and similar poisons to force an exit by this route. That this view is in the main correct seems highly probable, and if it is correct, it means that the way to avoid bronchitis is not by the stereotyped methods of feeding to 'keep up the strength,' and coddling to keep out the cold, but by such a restricted dietetic regime and general depuration of the system as will remove the illegitimate excretory strain from the bronchial tubes, and allow them to concentrate upon their legitimate work. The same is true of gouty asthma.

The lungs then must be regarded as supplementary excretory organs; but the system does not call upon them until it is in sore straits. When it is evident that they have been so called upon, and are operating in the front line, the proper course to adopt is to check the necessity for supplementary excretion by suitable general measures and by stimulating the activities of the ordinary excretory organs. The occasion is not one for poultices, linctuses, and bronchitis kettles; rather does it suggest old-fashioned aids to salvation, such as black draughts, sweating, fasting, and blood-letting. The nice old gentleman with a 'nasty cough,' and Aunt Matilda who is 'a martyr to the bronchitis,' deserve, not only pity, but also a purgative. It is, of course, true that irritants reach the bronchial tubes from without, especially in large cities, but the most frequent and irritating irritants come from within, and they do their irritating in trying to find an exit.

We take into our systems a considerable quantity of material which, though quite harmless, is nevertheless useless from the point of view of repairing waste. Such a substance is vegetable fibre, which is

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THE FOUR TYPES OF MAN

Melancholy: Sanguine: Choleric, and Phlegmatic
From a German Engraving of the sixteenth century

by its nature insusceptible of being dissolved by the digestive juices. When this fibre has been stripped of the useful material with which, in an ordinary vegetable, it is associated, the fibre itself is passed out along the intestines, and is ultimately discharged. A very large proportion of the matter evacuated as faeces consists of material of this kind. It used at one time to be thought that faeces were composed wholly of material which was not susceptible of digestion, and there is little doubt that, in a perfectly balanced scheme of intake and output, this would be nearly true. Unfortunately, however, our present scheme of living represents the reverse of a perfect balance; the dice are loaded in favour of the intake, so that Nature wisely utilizes the intestinal tract as a means of expelling a great many substances other than vegetable fibre and its equally harmless congeners. And many of these other substances are not only highly toxic, but are toxic in the very special and disastrous sense of paralysing the tract through which they pass. Some of the extraneous material which finds its way into the bowel does not so paralyse the tract: it irritates it, and diarrhoea with colic is the result. Such an event, unpleasant though it be, is a storm which soon wears itself out, and no ultimate harm ensues. With the paralysing toxins, however, the case is very different. They produce a partial paralysis of the bowel, thereby not only protecting themselves against discharge, but also ensuring a re-absorption into the circulation. Such is the secret of many cases of constipation, and the explanation of some of its terrible results.

There is another and a very important factor which enters into the production of overloading of the bowel, and that is the voluntary control exercised by the individual. The education of this control constitutes a very necessary part of the upbringing of the child; in obedience to social and scholastic demands, it is gradually strengthened in the growing period, so that when adult age is reached the control has acquired such an ascendancy over the original physiological desire for relief that the latter is scarcely appreciated, save at certain hours, and then but feebly. Civilized man, it has been said, spends one-half his life in cultivating constipation and the other half in campaigning against it.

These two elements, the excess of voluntary control and the paralysing effect of the toxins on the movements of the intestines, combine to produce the most serious effects upon the constitution. The retention or inadequate discharge of faecal matter leads to re-absorption of poisons of every description, with the inevitable result that the human soil becomes so richly manured that any and every microbe settles thereon and flourishes exceedingly. And, apart from frank and blatant microbic invasion, one has to remember the gross impurity of the circulating blood to which such a state of affairs gives rise. We have

seen that for the efficient performance of its functions every part of the body is dependent upon a pure blood supply. If the circulating fluid is loaded with toxins, as in chronic constipation it invariably is, then not only does the whole machine work badly, but certain parts of it, the most delicate, become perverted in their action. It is within the experience of most adults that inaction of the bowels, even though it be relative only, depresses the nervous system, giving rise to a lugubrious outlook on life which, on the necessary alvine relief being obtained, is changed at once to animation and optimism. It is surprising to find how commonly the hypochondriac, the kill-joy, and the croaker suffer from constipation.

It is sometimes said that the taking of purgatives and laxatives constitutes a bad habit, which, like other bad habits, should be resisted. If it be true—and the proposition is a debatable one—that purgatives are physiologically objectionable, it is true to a far finer degree of truth that even more physiologically objectionable are the evils which chronic intestinal stasis brings in its corrupt and unclean train. In comparison with the coarse crime of constipation, a pill is a peccadillo. Moreover, the only means by which purgatives can be physiologically resisted is by rendering them unnecessary, and the only way of doing this effectually is by dietetic means. The poisons which are paralysing the intestines must be arrested at their source, which is the trencher. They are produced by a plodding perseverance in surfeit of unsuitable foods, and until this practice is replaced by one of moderation in foods which are simple and suitable, the stasis will continue, in spite of abdominal belts, abdominal operations, and abdominal lubricants.

Besides man, the only constipated animal is the domestic dog; and he is constipated from exactly the same causes as those which determine constipation in his master. For purposes of cleanliness, he is taught to control his desire for evacuation; and he is given food, 'the same as we 'as ourselves,' which paralyses his intestinal activities. Of the two, however, the dog is in the better case; for he knows when to fast, whereas man does not.

There are more constipated people in the world than know themselves to be constipated; there are hundreds who live in the fools' paradise of a very partially emptied bowel. The habitually constipated person is commonly sad. He is sad in spirit and sad to look upon. The muddy complexion, the oily skin, the congested ears, and the malodorous emanations, are but a few of the stigmata which proclaim the hidden cesspool to those who know. And those who consent to display these horrors will complain to the doctor that they are martyrs to constipation—for they love to talk about it. The drunkard might with equal justice claim to be a martyr to delirium tremens. The cure for constipation is to eat wisely and not too well; to take plenty of active

outdoor exercise; and to drink pints of water every day; a simple prescription which is easily within every one's reach.

It is to be remembered that the blood-vessels, the arteries, which carry the blood to these excretory organs are necessarily subjected to the influence of the poisons which they carry there for disposal. One would therefore expect the arteries themselves to give evidence of degenerative changes before there is any obvious involvement of the emunctories. And such is often found to be the case. The old saying that a man is as old as his arteries has a special application to the arteries which supply the kidneys and the lungs and the nobler organs generally, because the poisons are delivered to these organs at what may be called nozzle intensity. The peculiar importance attaching to the condition of these organs and their associate arteries at middle age is that there is now still time in which to redress an adverse balance by limiting the supply of toxins and dealing actively with those which have already accumulated.

If a man is to avoid poisoning himself or is to mitigate so much of the process as may be inevitable, it is obvious that one of his principal preoccupations should be the nature of his intake. The two paths of intake are of course the air-passages and the gullet. In these days it fortunately is no longer necessary to insist upon the virtues of fresh air, theoretically at any rate. It is, however, only too true that the theoretical as opposed to the practical acceptance of the faith is still very much in the ascendant. Like the Scotch lady who spoke of love 'in the abstract,' the majority of people are content to pay lip-service to the principle while reserving to themselves a right to parsimony in the practice. People live and sleep behind hermetically sealed windows because they are afraid of draughts and chills. It is at middle age that people begin to dislike cold influences, and unless the dislike and its insidious nature are recognized it is all too easy to slide down the hill which leads to closed windows and stuffy rooms, especially in these days of centrally heated houses. A fully opened window in the night season should always be insisted upon. In the daytime such a thing is often difficult to obtain without a fight, but every man of forty should always bear in mind the paramount necessity for the purity of the air that he breathes, and for the cool freshness of the air with which his skin comes into contact; for he is at the parting of the ways, and the easy path is the wrong turning.

Diet

In the matter of the intake of food, the most difficult lesson for the middle-aged man to learn is by far the most important, namely restraint in quantity. The habit of large meals acquired in the period of youth

and muscular activity is looked upon as a matter of course; any suggestions as to lessening the amount are regarded with surprise and indignation. The ideal of keeping up the strength should give way to that of keeping down the weight, and this can only be effected by a serious attempt to lessen the sum total of the intake, as, for example, by the reduction of lunch to a bread-and-cheese minimum and the total abolition of afternoon tea. The question of the quality of the ingested food is, of course, of very great importance.

The very worst kinds of food are those which are nowadays habitually and generally consumed in large quantities by almost every adult and middle-aged person. These are the sticky foods represented by starches and sugars. At breakfast they are present as sugar added to tea or coffee; as bread, biscuits, and marmalade. At luncheon they appear in milk puddings and jam rolls. At afternoon tea there is a perfect orgy of them; they riot in bread and butter, cakes, scones, and buns. At dinner they come as tarts, either of fruit or jam, with a liberal allowance of bread between the courses. The intervals between these ascetic repasts are frequently relieved by chocolates, fondants, and various other kinds of sweets. It is computed that, on an average, each person in this country consumes between ninety and a hundred pounds of artificial sugar per annum; a quantity which represents a great excess over the moderate amount designed by Nature for our use. That amount may be estimated from the fact that our sweetest fruits contain a surprisingly small amount of sugar, and even this in the form of the easily digested fructose. Thus, cherries contain 10%, apples, pears, oranges, and apricots 8%, raspberries 7%, and strawberries 5%. Even the subtropical grapes and pine-apples contain, the former no more than 17%, and the latter 13%. What more powerful indictment than these facts supply, would it be possible to bring against the present-day practices of middle-aged people in the matter of sugar?

The gravamen of the charge which is often and quite reasonably urged against butcher's meat rests on the fact that the beasts from which it is derived are in an artificially induced state of fatty degeneration, that is, of serious ill-health, before they are killed. For this reason, if for no other, it is easy to draw a definite line of demarcation between butcher's meat on the one hand and fish and game on the other. Birds and fishes have been leading healthy lives up to the moment they are killed, and there can be no doubt that, eaten on the day on which they are killed, that is, when post-mortem decomposition is at its minimum, they do very little harm to healthy active people.

Many of the common foods, meats, sugars, and starches, having been placed in an *index expurgatorius*, it might reasonably be asked what forms of food, outside the index, can be considered as at once suitable to human consumption, and adequate to the primary and essential work

of repair upon which continued life depends. In reply to this, let us recall that the foods in the index are artificial foods, and that the foods proper to middle age are what are often called 'natural' foods. Natural foods are represented by dairy produce, uncooked vegetables, and uncooked fruits. Admitted into the category, but not as full members, are suitably cooked vegetables, dried fruits, bread, and biscuits. Game, fish, and poultry are included under a mild protest, for it must be admitted that whatever may be said against these on some grounds, the liver of birds and the roe of fishes contain valuable elements, even when cooked. Oysters, when taken raw, may claim full membership; cooked shell-fish, honorary membership only. Out of such a list it should be easy for the most exacting person to frame a scheme of living entirely satisfactory both to his physiological needs and to his aesthetic requirements. The term 'dairy produce' includes everything which a dairyman sells: milk, cream, butter, cheese, eggs, and honey; and 'uncooked vegetables' include a great many things which are not usually put into salads, such as carrots, turnips, dandelion leaves, nasturtium leaves, sorrel, thyme, cabbage, horse-radish, and cauliflower. Many of such vegetables are usually cooked, and people often express astonishment at the suggestion that they can be eaten raw. Not only can they be taken raw, but they can be so taken with great advantage, for they are often far more palatable in that state than when they have been cooked. Peas and brussels sprouts are good and useful, even when cooked. Leeks and onions may be taken cooked in the ordinary way. Potatoes should be cooked, and eaten in their skins, as many of their most valuable constituents lie just within their outer coating.

Fresh fruits, which are *par excellence* Nature's foods, should form a large element in every meal. There is nowadays no difficulty in finding a variety of these even in winter, because oranges, bananas, apples, and other fruits are largely imported into this country. Fresh fruits should take the place which puddings now unfortunately occupy in the ordinary dietary. Fruits contain sugar in a readily digestible form—indeed, the only digestible form—and mixed with cream they supply the palate with all that puddings can properly be expected to supply.

Eggs may be taken raw in a salad dressing or other sauces, or they may be poached and taken with vegetables. The longer an egg is boiled the more surely are its vitamins destroyed.

To enter now into detail. Breakfast should be of the continental type; that is, tea or coffee, toast and butter, and some fresh fruit. Compared to the stupefying meal with which the ordinary Englishman considers it his bounden duty to begin the day, this may seem unduly meagre. But, apart from the fact that it is the rule among continental peoples, which is eloquent as to its sufficiency, there is physiological

warrant for the practice. The morning is essentially the period of excretion, and the gastro-intestinal canal should be given as little fresh work as possible in order that energy may not be deflected from its legitimate channels. A glass of water on waking aids the metabolic work; anything over and above that tends to retard it.

Luncheon is usually taken in this country at half-past one. With a light breakfast, half an hour or even an hour earlier is more suitable, though the exact hour matters very little; it is mainly a matter of habit. And, like breakfast, in comparison with the ponderous meal which the well-to-do Englishman takes about midday, luncheon should be relatively light. An egg dish, a salad, some toast with butter and cheese, and plenty of fresh fruit of all kinds, is quite sufficient for most people. If the 'sweet tooth' becomes clamorous, then in addition to the above, some honey, or, under pressure, some jam, may be conceded, to go with the toast and butter. In winter, a cooked green vegetable—say spinach—with an egg, or an omelet *aux fines herbes*, may be looked upon with indulgence. This meal may profitably begin with a glass of water: cold douches should not be restricted to the exterior of the body. Tea and coffee are both agreeable stimulants, but inasmuch as both retard digestion, they are better avoided. Alcoholic drinks, even cider, if taken at all, should be reserved for the meal which is taken when the day's work is done—'No drinks before dinner' is an admirable rule at middle age.

Of the meal called afternoon tea it is difficult to write in terms of suitable restraint. The assemblage of concentrated indigestibles which is ingurgitated into the rebellious and still partially distended stomach at this wholly unnecessary meal, represents a waste of energy, material, and money, for which no excuse can possibly be found. The French, who lunch earlier than we do, never take it; thrift, and respect for the evening meal, combine to keep them in the paths of wisdom. People will sometimes assert that if they don't have tea they suffer from a 'sinking feeling' in the pit of the stomach. This is quite likely, because the feeling of which they complain, and attribute to hunger, is in reality a form of indigestion, for which the proper treatment is not tea, but muscular exercise.

It is found by the majority of people that it is best to defer 'the meal of the day' to an hour when it may be taken untrammelled by business calls and worries. And this plan is entirely in accordance with physiological principles. Leisure to eat slowly, and a mind free from the pressure of engagements, especially if these can be accompanied by congenial companionship, constitute the most suitable atmosphere for appetite, digestion, and assimilation. From among the suitable foods which have already been enumerated or indicated, it ought not to be difficult even for the most exacting gourmet to frame a menu which

would be entirely satisfactory. Fish and a salad; a bird with a green vegetable; toast, cheese, and fruit, varied by some of the etceteras, such as chicken's liver and cod's roe, already mentioned, ought to satisfy any one. It is not that these etceteras are in any degree necessary. Their mention is merely to show that a rational diet is in no sense a faddist or a starvation diet. For the majority of people much simpler fare will suffice. Provided that the meal rigidly excludes puddings, cakes, and other sweets, limits butcher's meat, and generously includes uncooked salads and uncooked fruits, with a suitable quantity of dairy produce, there is a wide choice for the remainder. This applies to healthy middle-aged people who wish to keep fit. Unhealthy people who want to get well are in a different category.

It is a good general rule which bids us to eat sparingly of the things that we enjoy. A well-known physician who has retained his mental and physical efficiency up to a very advanced age attributes his good health to the fact that he has always risen from every meal feeling that he could sit down and eat it all over again. That, no doubt, is a counsel too near perfection for general application to the ordinary man of middle age, but it contains more virtue and much more common sense than the Victorian trencherman's pious practice of eating as much as he possibly could. He constricted his neck with white chokers, and choked his stomach with meat. It is no wonder that he was a hypocrite who died young.

The digestive organs, like the body as a whole, have need of certain periods of rest. In the modern scheme of things, these organs, so far from being permitted to rest, are driven full steam ahead for the full twenty-four hours, and in most cases the safety valves are wadded round and about with adipose tissue.

Fasting

It is a great pity that fasting has gone out of fashion. For the middle-aged it is an excellent occasional discipline. By fasting, is meant complete abstinence from everything except water during a specified period. The process has been referred to elsewhere, but a more detailed regime is given here. To obtain the maximum benefit from this ordeal, lest absorption of deleterious matters should take place from the intestines, the fast should be preceded by purgation. A dose of grey powder at night, followed by a dose of Epsom salts the following morning, will do all that is necessary. As soon as the desired result is obtained the fast begins. While it continues, nothing but water with bicarbonate of soda (two teaspoonfuls to a pint) must pass the lips, and smoking is not allowed. The length of its duration

depends upon many considerations, into which it is impossible to enter here; suffice it to say that a moderate fast should extend over three full days. If the intestinal canal is really empty, the ordeal is by no means as fearsome as it seems, in anticipation, to be. On the first day there is a certain desire for food at the hours of the customary meals, but the desire soon passes, especially if mind or body, or both, are fully occupied. On the second day the desire for food is sensibly diminished, and on the third day one usually has no desire for food whatever. During this period of three days the faster must not pity himself. He must go about his usual business in the ordinary way and take moderate exercise. The process cannot be described as stimulating, but it is much less depressing than one might imagine. One feels well, but as a rule rather sleepy, and there is no reason why the desire for sleep should not be indulged. On the fourth day the fast is broken by a very small meal, say two apples and a cup of tea or coffee. The two other meals of that day should also be very small, and of the raw fruit variety. On the fifth day, the ordinary way of life is resumed, with a feeling of rejuvenation and added zest.

In the case of people over forty years of age who are obliged to lead sedentary lives, a fast of this kind may profitably be undertaken every three months. Some people prefer more frequent fasts of shorter duration, but experience goes to show that the full benefit of abstinence is not forthcoming from a fast of less than three days' duration. The effect of fasting is to cause the organism to live on its reserves. The reserves, in the case of most people, consist of superfluous fat and a great deal of partially assimilated material. The individual is not starving in a physiological sense, because he is living on material which he has been unwittingly putting by for a rainy day. In ordinary modern conditions the rainy day never arrives, and the useless material goes on accumulating. It is therefore necessary to produce the rainy day artificially. When this is done, there is a sort of spring-cleaning of all the tissues, and the machine starts work with all its bearings freed from grit and the fires burning brightly. Fasting is a sensible, harmless, physiological, and inexpensive method of keeping in good health; and one of the most potent means of redressing the balance when things go wrong. It is Nature's way.

Clothing

The general principles of sensible dress, already discussed, are as applicable to the middle-aged as to the young. As the body's reactive power lessens, however, a little more protection from extremes of temperature is called for, but the evils of over-coddling must not be disregarded. Most people speak as though some materials, such as

fur and flannel, were capable of imparting warmth to the human body. This is a mistake. No material is warm of itself. All the heat comes from the surface of the body, so that the action of the 'warmest' material is merely that of preventing the escape of the surface heat. But in the case of a complicated organ like the skin, it is impossible to modify one function without bringing about corresponding modifications in the others. If, then, the heat-regulating function is interfered with by obstructing loss of heat from the surface, it also means that cold influences fail to reach the integument; nerve-messages become sluggish, arteries and veins fail to contract normally, and the blood, instead of being driven inward, tarries on the surface to increase perspiration.

It is thus obvious that the admittedly necessary interference of heat regulation by clothing must be very nicely adjusted to the real needs of the individual and his environment. From late childhood to early adult life the interference should be as little as circumstances will reasonably permit. The healthy young human animal has his own boisterous methods for keeping himself warm; and however noisy and distracting to his elders these methods may be, they afford no excuse for the present system of swaddling and coddling him into silent inertia. But it is with the advent of self-indulgent middle age that the real trouble begins. The period of the bald head and the bulging abdomen is also the period of the long-sleeved woollen vest and the long-legged woollen pants, reinforced peradventure by a double-breasted chest-protector, wrought of red flannel; mystic and actinic.

In the light of what has already been said it should require very little imagination to realize what over-clothing carries with it in derangement of the cutaneous functions and the consequent diminution of resistance to disease, not in the skin only, but in all parts of the body. The superficial vessels never being cooled by the natural method of cutaneous exposure, this necessary function is thrown upon the only other organs whose blood-vessels are brought into direct contact with the outside air, namely, the respiratory organs. This extra work has too often to be performed by them in an atmosphere, not cool and fresh, but laden with warm gases and moisture, for many people dread fresh air more than they fear the devil. The result of this combination of senescence and stupidity is inflammation of the air-passages which, in slight degrees, is euphemistically described as a chill; or, in severe manifestations, as a catarrh or a bronchitis. In explanation of these afflictions it is useless to invoke the microbe; the microbe does not flourish in air-passages until they have been rendered unhealthy by performing tasks which are properly the work of other organs. Once more let us remember that it is the soil that matters even more than the seed.

The same applies to the other viscera and their derangements. The blood which should be busily flushing the brain to promote intelligence, and gaily coursing through the liver to promote cleanliness, is held a languid prisoner in the cutaneous vessels by sodden woollen garments, with the natural result of somnolence, lethargy, and stupidity; with indigestion, constipation, pyorrhoea, and a host of those minor miseries which are usually attributed to the caprice of a jealous God.

The proper purpose of clothing, then, is not so much the promotion of pleasant over-warmth as the avoidance of paralysing degrees of cold. The line between the two is—at first at any rate—admittedly rather fine. But the constant cultivation of 'comfortable' conditions is a degenerate and dangerous practice. As with morphia, the inevitable tendency is gradually to raise the standard and increase the dose, until the point is reached where all degrees of cold become intolerable. This tendency should be kept well in mind, and every effort should be made to resist it. Self-coddling is one of those bad habits which grows with what it feeds on. For this and other reasons it is a great pity that the fashion for cold baths has died out. The morning hot bath dilates the cutaneous vessels, and thus renders the call for 'warm' clothing more imperative. The whole surface of the skin should be exposed, if not to cold water, then certainly to cold fresh air, every morning. It is only thus that the contractile power of the vessels can be kept in training, and the skin itself in a state of 'tonus.' The man with an elastic skin enjoys the cold; he finds it stimulating mentally and physically; it is only the individual with the skin which constant coddling has deprived of its reactions who dreads it. If there were more cold bathing there would be less face-lifting.

The most serious offence against science and common sense in clothing is comprised in the word 'constriction.' Constriction interferes with the circulation of the blood and lymph, with nerve messages, with muscular contraction, and consequently with movement. When applied to accessible organs, as in the abdomen or neck, it embarrasses their functions and impedes the working of the whole economy. All are familiar with the discomfort arising from tight garters and tight sock suspenders, but not every one realizes that such constrictions may be the sole cause of general fatigue and irritability, and that they are often responsible for varicose veins and ulcers; yet such is emphatically the case. If a region of the body were to be sought out in which even a moderate degree of constriction would do the maximum of damage, that region would certainly be the neck. Here we find together some of the most important anatomical structures in the whole body: arteries, veins, nerves, glands, air-passages, closely packed, and readily accessible from without. It is no wonder that our mid-Victorian forbears with their high 'chokers' died prematurely of apoplectic self-satisfaction.

In the matter of clothing, then, coddling and constriction are the two great enemies to fitness and efficiency. When they go hand in hand, as they frequently do, the stage is set for a tragedy, which, though long drawn out and uneventful, is sad because it is stupid. All that is necessary to avoid it is a little courage and common sense. Courage to face and to cultivate a certain amount of cold; and common sense in declining constriction. It is a hopeful sign that the younger generation of both sexes seems to show a taste for freedom in dress as well as in other social habits.

Failing Eyesight

Among what may be called the normal accompaniments of middle age, none is more significant than failing eyesight. The sight for distance remains unimpaired, but bit by bit near vision becomes more difficult until the daily paper must be held at arm's length if the letters are to be clearly deciphered. The disability is quite easily corrected by suitable glasses, best prescribed by an experienced ophthalmic surgeon, who is capable of detecting and correcting any other visual defect, such as a slight astigmatism, the presence of which is liable to complicate the situation. There is another reason why a medical ocular expert should be given the opportunity for examining the retina of the middle-aged, which is that the retinal artery is the only artery in the body which can be seen under ordinary circumstances, and the condition of that artery as revealed by the ophthalmoscope may afford invaluable information as to the state of the arteries in the rest of the body. A perfectly normal eye is not easily overstrained, but perfectly normal eyesight is as rare as a perfectly straight nose. When there is an uncorrected visual error, an amount of work which is harmless and indifferent to the normal eye becomes a real penance, not only to the abnormal eye itself, but to the nervous system of its possessor. Eye-strains of all degree are capable of imposing much misery of various kinds upon all sorts of people. A skilful refractionist can be a veritable saviour in such circumstances, and may lift and clarify the whole outlook on life.

Deafness

Another tell-tale signal of the enemy's passage, and a very sinister one, is deafness. It is sinister because, unlike ageing sight, the impairment of hearing, which is liable to come at middle age, is often incurable. It can, however, frequently be arrested, the method of arrest being not by applications to the ear itself, still less by operations, but by a close attention to such rules of healthy living as will stop the supply of the poisons which cause the mischief. None of the degenerative changes of

middle age is more surely due to toxins than the progressive deafness which afflicts so many relatively young people. Ringing or singing in the ears is a very common accompaniment of deafness, though it may and often does arise independently of any defect in hearing. Subjective sounds of various kinds are often heard by people at the beginning of deafness, and they give rise to much annoyance.

Singing in the ears is often associated with giddiness, of which it is only one of many causes. The ocular troubles just referred to are probably the most common cause of vertigo, though digestive disturbances and arterial derangements are certainly also common; whilst among the many counts in the indictment against tobacco, its power to provoke giddiness must be given a high place. A giddiness which cannot be 'placed' is almost certainly stomachic. It is said that the impairment of hearing which comes with middle age comes more frequently and definitely to town-dwellers than it does to their country cousins. Deafness is, indeed, regarded by some as an automatic protective measure for enabling the nervous system to escape from the over-stimulation which loud noises impose, such as those which in towns emanate from motor engines and horns, and road drills. It is true that a measure of deafness is an advantage to such as attend public dinners and other functions, of which oratory forms a part.

Skin Troubles

As a man progresses down the hill he shows evidences of his decline in the skin and its appendages. The integument tends to become dry, perspiration is scarce, and, owing to the lessening of the skin's elasticity, wrinkles multiply and deepen. The hair of the head becomes grey, because pigment is no longer formed, and ultimately white because the individual hairs are invaded by air bubbles. The factor which decides the greying of hair is not known. Some people retain a full measure of colour into advanced old age, whilst others become quite white-haired in the thirties and even the twenties. Sir Thomas Browne, the sage of Norwich, says: 'Hairs make fallible Predictions and many Temples early gray have outlived the Psalmists Period.' Bacon says: 'Hasty grey hairs without baldness is a token of long time; contrarily, if they be accompanied by baldness.' Baldness is thought by many to be due to a want of stimulation of the roots. Our forbears who wore their hair long rarely grew bald. To keep it clean and in place, short hair, in comparison with long, requires very little brushing and combing and drying, all of which stimulate the roots. When baldness threatens, massage, brushing, combing, and rubbing should be practised diligently. So also should washing; with frequent firm friction with the finger-tips to loosen and supple the scalp.

ECZEMA.

One of the chief skin troubles of middle age is eczema. It is usually attributed to gout and is often caused by dietetic imprudences. The two situations which it seems to favour are the ear passages and the anus, but it is by no means confined to these. Wherever situated, it is very irritating, and much trouble frequently results from the inevitable scratching during sleep. The only reference to treatment which is called for here is the warning that eczema of the kind referred to is always aggravated by the use of soap; and that when it appears in the ear, powders as dressings are much better borne than ointments.

FURUNCULOSIS.

Another common skin affection of middle life is furunculosis, that is, boils and carbuncles. Boils attack any part of the body except the palms of the hands and soles of the feet, but they have a special predilection for the back of the neck, the armpits, and the hips. The causes of these very troublesome and painful eruptions are by no means easy to ascertain in any individual case. One thing at any rate is certain, that they are due to a blood-poisoning, and that the poison in a vast number of cases comes from the digestive tract. Boils are not due, as used to be supposed, to 'a poverty of blood'; they are due to impurity of the blood. A great deal of unnecessary suffering is commonly inflicted upon victims of this painful complaint by the fact that almost every one — layman or doctor — wants to 'squeeze' a boil. Such barbaric treatment not only fails to do any good, but must of necessity do harm. An important thing to remember is that boils and carbuncles are often due to sugar in the urine—are, in short, a sign of diabetes. For this reason a skin manifestation of this kind must always be regarded with suspicion, if not with anxiety, and an appeal to a competent physician should be made without delay.

THE MENOPAUSE

Inasmuch as the period about middle age has a special significance for woman, it seems advisable to refer briefly to the phenomena of the climacteric or, as it is called, the menopause. The most obvious feature in the change which takes place in most women between forty and fifty is the irregularity and ultimate cessation of the monthly period. This is a sign that the reproductive life of the individual is at an end; she enters upon an entirely new and, to her, strange phase of life in which her character and outward seeming often undergo very considerable changes. The physical alteration is, usually, but not always, in the direction of obesity; whilst in the character there is sometimes a

lessening of the female traits; in extreme cases, to the point of becoming definitely male in outlook and manner. The transition from the one state to the other is often unpleasant, not seldom it is very stormy. The brunt of the trouble falls upon the nervous system, which, especially in childless woman, is liable to be seriously disturbed. It is unfortunately quite impossible to say when the menopause will begin, how long it will last, and what form it will take—whether it will 'pass in the night' as the saying is, or whether it will bring with it a devastating physical and mental storm protracted over a span of several months, possibly of years. The main hygienic point to remember about the phenomenon is that it indicates not only an end of the reproductive power, but what is equally important to the individual health, it means a definite reduction of activity in certain important endocrine glands. Women past the climacteric sometimes become subject to diseases such as rheumatism, and other toxic states, from which they may formerly have been immune. If this fact is borne in mind, there is little difficulty in realizing the danger of 'feeding-up' at the climacteric. The way to keep up the strength is not by loading oneself with material which one is unable to excrete, but by helping to purify the blood stream so that the toxins may not reach the already sorely-tried nervous system. Such are the nervous disturbances at the menopause that many women fly to drugs and alcoholic drinks to tide them over their difficulties. Such drugs as aspirin and bromides are harmless enough in themselves, and often do give considerable relief; but they should be used with caution because, like all sedatives of their type, they tend to lose their effect. This too often leads either to increased dosing or the change to some drug which is not so harmless. Wines and spirits serve in a very special way to relieve the symptoms of irritability and depression and are therefore very liable to abuse.

VI—OLD AGE

Have you not a moist eye, a dry hand, a yellow cheek, a white beard, a decreasing leg, an increasing belly? Is not your voice broken, your wind short, your chin double, your wit single, and every part about you blasted with antiquity? And will you yet call yourself young?—*King Henry IV*, Part II, Act I, sc. ii.

THE above classical description of the unmistakable signs of the onset of old age (addressed by the Lord Chief Justice to Falstaff) comprises most of the physical evidences which proclaim the advent of the last phase, but Shakespeare makes no attempt, either in this passage or another, to indicate the numerical age at which these symptoms may be expected to appear. There is, in truth, nothing in our present knowledge, or very little, which explains to us why it should be that of two men who start life's journey on substantially equal terms, one should last in vigour till eighty, while the other peters feebly out at fifty. The answer to the enigma would almost surely be found in the circulatory system.

THE CIRCULATORY SYSTEM

The saying that a man is as old as his arteries is quite correct. An American has put it more graphically by saying that long life is due to good tubing, and he goes on to remark that the grade of tubing is a matter of heredity: that is why longevity seems to run in families. It is not altogether fair to lay the whole blame for degeneration of arteries upon the original grade of tubing, because the quality of the traversing blood must certainly be taken into consideration. If the blood is charged with poisons, those poisons will certainly affect the walls of the conduits, and however good the material of which the walls may originally have been composed, they cannot escape the influence of toxins which have been bathing them for thirty or forty years. There are, of course, many kinds of poison, and those which have a special predilection for arterial walls have not yet been accurately differentiated; but we know enough to be quite certain that the toxins which are comprised under the term gouty and rheumatic, those, namely, which come from improper feeding, from sluggish excretion, insufficient exercise, and lack of oxygen, are those which give rise to premature degeneration of the arterial wall.

THE HEART.

In speaking of the circulatory system people are, curiously enough, apt to leave the heart out of consideration. The reason is that an originally sound heart will respond repeatedly and gallantly to almost anything which is asked of it in the way of muscular strain, so long as it is not affected by toxins or overloaded with fat. The toxins of certain diseases, notably rheumatic fever, tonsillitis, and St. Vitus's dance or chorea, attack the valves of the heart; seriously compromising its efficiency as a mechanical instrument, and impairing its power of response to exertion. The effect of fat is also largely mechanical. The adipose tissue overlies and embraces the essential muscular tissues, interfering with the expansion and contraction of the pumping heart, just as a weight on a man's chest interferes with the expansion of his lungs. The circulatory system is thus the key system in the prolongation of life, and if it is to receive fair play care must be taken to supply it with pure unpoisoned blood, and to refrain from any possible mechanical embarrassment of the heart by adipose tissue or otherwise. Here is the basis of the saying, already quoted, that fat men don't make old bones.

The Nervous System

Second only in importance to the circulatory system in determining the question of longevity is the mind, with its physical organ, the central nervous system. The man of no occupation, whose thoughts revolve ever in the vicious circle of his own health—what is good for him, how to avoid chills and how to escape microbes—is generally short-lived. It was Plato who said pithily of such people that 'attention to health is the greatest hindrance to life.' Apart from these definite neurotics, there can be no doubt that longevity is influenced by what we still call 'temperament.' By this word our forefathers understood the precise manner in which the 'humours' of the blood were mixed or blended. The theory of the humours, after being smilingly discarded, has now been revised and justified by our knowledge of the endocrine glands; and temperament, or character of make-up, is now recognized as being dependent upon the manner in which the essences of these glands are mixed. Despite its constant use, and not infrequent abuse, of energy, the 'sanguine' temperament which antagonizes all and sundry by questioning all things and contesting all things, lasts longer than the 'phlegmatic,' which believeth all things and endureth all things. Impatience, even when it rejoiceth in iniquity, has a longer outlook than charity. He who suffers fools gladly should not buy an annuity, for nothing kills like boredom. Bacon says: 'They are happy men whose natures sort with their vocations.' An uncongenial mental environ-

ment, such as a nagging wife, is a canker to the nervous system which poisons the blood. The French expression for irritation and annoyance, *se faire du mauvais sang* (to make bad blood for oneself), is literally and physiologically true. Another French saying has a point of application here: *Pour vivre longtemps il faut une bonne digestion et un mauvais cœur*—to live long you require a good digestion and a callous heart—that is, a disposition which is not over-susceptible to moving influences, especially a morbid degree of pity and sympathy in sorrow; for over-indulgence of these emotions exhausts the nervous system and wears it out.

The Glands

If we take Dean Swift at all seriously we must conclude that really great age, even with fair health, is far from desirable. To emphasize this point of view he portrays for us the Struldbrugs whom Gulliver found on the island of Luggnagg. These creatures never died; 'they were not only opinionative, peevish, covetous, morose, vain, and talkative, but incapable of friendship and dead to all natural affections. Envy and impotent desires were their prevailing passions.' In these days such people would probably be treated by glandular extracts, which, in the view of many competent physicians, are capable not only of promoting longevity, but also of rejuvenating the mental outlook. A great deal of work has been done in the matter of glandular physiology, but there are still many problems awaiting solution. Meanwhile, the less we dogmatize about the possibilities the better.

The Digestion

The importance of a good digestion in the attainment of hale old age is, of course, axiomatic. In the promotion and maintenance of health food is clearly a prime factor; upon the material with which physiological waste is repaired will largely depend the physical condition of the individual. It is therefore obvious that the efficiency of the digestive organs which elaborate and absorb the reparative material must be so maintained as to enable them to do their work smoothly. The main line of such treatment is to arrange that the ageing organs shall not be called upon to do the work of organs still young and vigorous. The stimulating diet, the highly seasoned meats and highly sugared cereals, should give place to simple natural foods, the fruits, salads, and dairy produce. The change to these will diminish the work of digestion and assimilation and lessen the amount of poison reaching the blood-stream, so that the neutralizing agencies will be given some respite, and the all-important excretory organs no longer be driven at high pressure. This is a matter that often calls for some degree of insistence;

for old people often have a good appetite, and they like a highly seasoned diet on account of its stimulating properties. In this lies the explanation of the fact that when first made to eat simple foods, old people complain bitterly that such things give them indigestion; and it is true. The stomach has become so accustomed to stimulation that in the absence of the usual spur too little gastric juice is secreted, and very real discomfort results. In such cases the education in dietetic righteousness must be gradual.

The Excretory Organs

The slowing down of function which is the main characteristic even of healthy old age is, above all things, to be remembered in connection with the excretory organs. One of the reasons why the senile lung is so prone to bronchitis is that the air-passages are called upon to aid the other emunctories in getting rid of poisons. This being a task for which the bronchial tubes are but poorly adapted, the poisons irritate the passages, with the result that bronchitic and asthmatic attacks are common. People find it quite easy to understand how it is that fogs irritate the air-passages by applying an irritant from without, but the same people are quite incredulous when told that equally irritating poisons come from within. The way to avoid respiratory troubles in old age is so to order the life that the blood carries as few poisons as possible to the labouring lungs, and this can only be done when the ordinary rules of sound simple living are observed; especially the rules of sound dietetics and those which enjoin the open window and the absence of such adventitious irritants as tobacco smoke. This question of tobacco will again be considered later, but here it seems convenient to insist upon the fact that smoking weakens the bodily defences in many organs, and systems, but more especially and perniciously in the organs of respiration.

THE SKIN.

The importance of the excretory function of the skin is very generally belittled; but the action of a healthy skin certainly aids in the work of ridding the system of toxins, and ought therefore to be maintained in good working order as long as possible. The trouble is that in old age the skin loses its elasticity, and becomes smooth, thin, and dry; whilst the little hair glands and sweat glands lessen in activity. If the integument is to be kept in being as an excretory organ, it must be kept in training, as it were, by the alternate applications of heat and cold, by massage, and by exposure to the influences of air and light. This is not to advocate the exposure of the whole body to the sun's rays for long periods. If there is any justification for such exposure in the case of the young and the middle-aged (which is doubtful), there can be no

excuse for subjecting old people to a violent stimulation, demanding an equally violent reaction which they are quite incapable of producing. The lessened cutaneous response to stimuli in old people is shown in their tolerance of parasites. Where lifelong habit cannot be relied upon, very special care is necessary to ensure cleanliness, because the blunted reactions fail to operate the ordinary signals, and no warning is given of conditions which may demand serious attention. The warts which not infrequently develop on old people, especially on the temples, are manifestations of a degenerative process, and it is not wise to interfere with them, for when irritated they are said to show a tendency to become malignant.

One of the most troublesome afflictions of the skin in old age is the itching that often accompanies the atrophy which sooner or later takes place. The irritation appropriately called 'formication' is described as a sensation resembling that produced by a multitude of insects. It is often aggravated to the point of real pain by the warmth of the bed, and causes a great deal of restlessness and insomnia. If those in charge of such a case will bear in mind that the very troublesome symptom is due to atrophy and degeneration in the neighbourhood of the nerve terminals in the skin, the general lines of treatment will become clear. These lines comprise the daily diligent stimulation of the skin by hot and cold bathing, by massage, and by ultra-violet rays, after every care has been taken by laxatives, colonic lavage, and otherwise to ensure that the circulating blood is as free from irritant toxins as is reasonably possible. A useful method of applying a stimulant to the skin of old people is by the regular exercise of the underlying muscles. The absence of fat between skin and muscle which usually obtains in old age means that if the muscles are exercised regularly, gently, and systematically, the skin is, so to speak, massaged from within. This is a method of treating itching and such other cutaneous degenerations as warts, which often yields surprisingly good results. Such exercises must, of course, be regulated in accordance with the strength of the patient, who should be taught if necessary to perform them in bed.

THE KIDNEYS.

The poisons which accumulate in the system are, so far as the most actively harmful are concerned, normally and physiologically expelled by the kidneys. In earlier years the kidneys are very efficient organs, and easily debarrass the body both of the usual waste products of tissue change, and of any extraneous toxins which may have entered. Acute kidney disease, which denotes acute poisoning, is of comparatively rare occurrence; but chronic kidney disease, which denotes slow or chronic poisoning, occurs in its various forms with ever-increasing frequency as the years advance. It has been argued that most of the

circulatory troubles of old age have their origin directly or indirectly in the kidneys. However this may be, it is certain that when the kidneys lose their vigour the process of chronic poisoning puts on pace and gravity. They are by far the most important of the excretory organs, and any signals of distress sent out by them should be given immediate and careful attention. This is a matter which lends emphasis to the wisdom of an occasional, say an annual, overhaul by a competent physician; because the signals of renal distress are not obvious; there is no pain—at most some inconvenience—no rise of temperature, and no disability. Yet an examination of the urine by an expert may reveal considerable mischief, which, though remediable in the early stages, will, if neglected, pass rapidly to a serious issue. There are, for example no outward symptoms which serve to reveal Bright's disease or diabetes at its beginning, but a very simple routine examination of the urine would immediately unmask either.

Another serious condition which is liable to escape early notice is high blood-pressure. This is usually regarded as a derangement of the circulatory system, but in many serious cases it is due to kidney trouble. The kidneys, in common with the other emunctories, have failed to rid the blood of damage-dealing toxins, so the toxins continue to circulate. The effect of this is that the arteries lose their elasticity, and the irritated kidneys lose their power of voiding undesirable matters. The pressure of blood inside the arteries now rises, and the condition known as high tension results. The responsibility of the kidneys for a large measure of unduly high blood-pressure in later life is undoubted. It is the ever-recurring story of undischarged toxins concentrating upon a particular system or organ, to give rise to symptoms which are attributed to primary disease in the organ itself. When furnished with healthy blood arteries and kidneys do not degenerate, and arterial tension remains normal. Owing to causes which are not yet well understood blood-pressure seems to rise with advancing years, and sometimes reaches with impunity a point which in a younger person would justify serious anxiety. It is said that a rough way of estimating the systolic blood-pressure in figures which should represent the ordinary standards is to add the individual's age to the figure 100; so that in the case of a person of twenty years of age the blood-pressure would be 120; at forty years, 140, and so on. This rather rough and ready method is not too inaccurate if the formula is not over-rigidly applied. It may be regarded as reliable enough up to fifty years of age, but one cannot admit as normal a blood-pressure which reaches beyond 160. Such a figure encountered in a person of seventy years of age or over need cause no anxiety, but when present in any one younger—even when as old as sixty—the advice of a physician should be sought. A great deal of unnecessary alarm is caused to old people by the

prognostications and jeremiads of inexperienced people armed with a sphygmomanometer. High blood-pressure is often quite transitory, and in old people very often quite harmless. It is indeed said by some authorities that a high pressure in old people is essential, if not to life itself, then certainly to any reasonable enjoyment of life. Harm is done by uninstructed enthusiasts who try to reduce high pressure with new drugs. The drugs often depress the spirits, whilst the pressure remains high.

The kidneys are liable to suffer from a repercussion of troubles which occur lower down in the urinary tract, in the bladder and prostate gland. The enlargement of the prostate, which may be regarded as one of the chief physical penalties of advancing years, prevents the bladder from completely emptying itself, with the result that the retained urine, acting as an irritant, causes inflammation of a mild but troublesome kind in the bladder. The irritation and inflammation are liable to travel upwards, and involve the kidney. Such a consummation is very much to be feared, and steps should be taken to deal with the condition in its early stages. An enlarged prostate may be suspected when the patient is obliged to leave his bed more than once in the night to relieve his bladder, and when there is a difficulty in beginning the act of micturition. These symptoms seem harmless in themselves, but it should be explained to the patient that if neglected they may lead to serious mischief. The removal of an enlarged prostate is one of the most justifiable of surgical operations, even in very old people.

THE INTESTINES.

So great is the recognized importance of the intestinal emunctory that of any one who has arrived at real old age it may quite safely be said that he can have very little to learn in this respect. And that little resolves itself into such simple advice as the desirability of varying any necessary aperient from time to time, so that there is no danger of a tolerance becoming established. As a rule the preparations containing paraffin oil, of which there are so many excellent ones on the market, suit old people very well. Natural salts, especially those which are compounded of the fruit acids, may also be taken. A very reliable laxative is cascara, which, in common with those just mentioned, has the merit of being free from that tendency to 'after constipation,' which is the defect of so many otherwise excellent aperients. In spite of this latter drawback, which undoubtedly attaches to it, castor oil should be in the medicine cupboard of all old people. In an emergency or as an occasional aid to the 'flushing of the drains' it has no rival. It does its work effectually, for the most part painlessly, and without any sort of danger. Grey powder and calomel are given too freely to old people. They are not suitable household remedies in old age.

Conduct of Life in Old Age

In the general hygienic management of old people, perhaps the most important thing is that they should be kept up to the collar. Their natural tendency to relax and let things slide must be vigorously resisted. Hot rooms, fur-lined coats, lifts, bath-chairs, and such like, must be forbidden save in exceptional cases. The trouble is that people slip into these ways imperceptibly, and that when once a life of semi-invalidism has been established the more wholesome rarefied air of active resistance is very difficult to recapture. And as a rule the tendency is for those about an old person to encourage the hot-house atmosphere. It is the gradual curtailment of bodily and mental exercise which lies at the root of premature decline. Time after time we witness the break-up of seemingly healthy men who had boasted of their independence of bodily exercise. There can be no such independence; for man is an animal first, and thereafter anything which civilization can make of him. His obedience to the laws of animal physiology is an essential condition precedent to his usefulness in any sphere. The kind of exercise most suitable to an individual case will depend upon things too numerous to discuss here; but in a general way it is safe to say that it is wiser to continue with an accustomed exercise, even if it be the rather dull discipline of walking, than to take to a thing which is new and strenuous. It is the fashion to speak of golf as an old man's game. It is certainly a game which an old man may, and probably should, *continue* to play, but it is a counsel of very doubtful wisdom to advise an old man to begin to play it. It can be very fatiguing both to the muscles and to the temper. Games certainly have their place as hobbies, and hobbies of all sorts are worth cultivating by the old, especially such as will give intellectual pleasure combined with suitable exercise in the open air. For such a purpose gardening stands pre-eminent, and even those to whom this delight is impossible should learn and cultivate the habit of botanizing. Bird watching is another hobby which is open to most people, and any one interested in this fascinating pursuit will find no lack of encouragement in the various societies established for research in such matters. The maintenance of cerebral activity in old people is a thing of such importance as to be worthy of much more forethought than it usually receives. Men who are aware that they will be obliged to retire from business at a certain age should make a point of cultivating an interest in some branch of mental activity several years before their retirement actually occurs, so that the loss of their work does not leave them intellectually stranded. Public life, with its interests and controversies, has been the means of keeping alive many people who would otherwise have fallen into mental torpor or dotage. The rust lies in wait in the scabbard.

Sleep

In considering the causes of this tendency to rust in old age some physicians have been very emphatic as to the complicity of too much sleep. Sir Hermann Weber, himself an advocate of strict moderation in this matter (as in all others), quotes with approval Sir John Sinclair, a physician famous about a hundred years ago, to this effect: 'It is proper to add that nothing is more pernicious than too much sleep. It brings on a dullness and sluggishness of all the animal functions and materially tends to weaken the body. It blunts and destroys the senses and renders both the body and the mind unfit for action.' Though this is still true to some extent, it is less true to-day than it was when the words were written; because sensible people now sleep with an open window, whereas in those days not only were windows tightly closed, but heavy curtains draped both window and bed, so that included under the term 'sleep' was, in reality, a fair measure of carbonic acid stupor. A leading physician of a later date, Sir Clifford Allbutt, said: 'If I get less than eight hours I have invariably to make it up during the week or be the slacker for the loss. And I have thought that many men who to my knowledge had stolen hours from sleep to give to work had in the course of years borrowed at high usury.'

The bedstead of an elderly person should be so constructed as to slope gently down from heel to heart. The height of the former above the latter need not be more than four inches. This can be secured by obtaining four-inch wooden blocks from the local carpenter, or by using out-of-date price lists, to place under the lower end of the bed. The upper end may be pillowed to any desired extent. This little expedient eases the work of the heart and circulation, and by keeping the urine away from the neck of the bladder it tends to decrease the frequency of those dreaded exits from the bed in order to make water.

Blunted Responses

The most noticeable psycho-physiological feature about old age is the slow and seemingly dissociated reaction to stimuli of almost all kinds. This should be ever present to the mind of any one who has to deal with old folk. This blunted reaction is particularly apparent in the matter of pain. What in a young adult would amount to excruciating and unbearable agony, such for example as the pain of gall-stone or renal colic, becomes so much reduced in old age as to be often described by the patient merely as a vague discomfort. To this rule, however, there are two outstanding exceptions to which reference has already been made. One is neuritis, which—using the term in its true sense and not as synonymous with neuralgia—is liable in old

people to be exceptionally severe and exceptionally refractory to ordinary treatment. The pains, for example, which so often accompany the incidence or subsidence of shingles cause so much suffering as to compel the use of morphine, a remedy which should not in such cases be withheld without some very good reason.

The generalized itching of old people is often troublesome and irritating in a very high degree, and although not exactly painful, it can, as has been said, be so severe as to deprive the patient of sleep and render every movement, almost every posture, during the day a burden too heavy to bear.

Another and a very serious exception to the rule of blunted response is provided by the enhanced susceptibility to drugs which is the rule with old people. As this is quite the reverse of what one would expect, the fact is one which should be kept in mind by those who have care of the old. Such household remedies as the bromides, calomel, grey powder, and laudanum, while fairly safe in the case of an ordinary adult, may easily become lethal in the hands of an heroic and impatient nurse in attendance upon an aged patient.

Periodical Examination

The desirability of a periodical thorough examination is very marked in the case of old people, however much they may seem to be above medical suspicion. It is a prudent measure for all responsible adults, the blunted response to which reference has been made. The insensitiveness to pain can easily mask a condition which, though curable in its earlier stages, may, if undetected, march rapidly to a fatal conclusion. Even such a serious disease as pneumonia may cause no pain, no cough, and no fever; and there are many other conditions, less dangerous perhaps, but even more stealthy, which only a thorough examination will reveal. Diabetes is one of these.

The blunting of reaction is often very pronounced in the mentality. The memory, while unusually good for events of long ago, becomes less receptive of recent events, and especially bad for names. Memory is one of the things which must not be allowed to rust; it does so very easily, and old people should be warned to exercise the memory as conscientiously as they exercise their muscles. Whether luckily or otherwise, it is a fact that the emotions are less acute in the aged. When people talk about an old man having died of a broken heart they talk nonsense. There are unfortunately no ready means for combating the tendency to mental deterioration which comes with age and relative disuse. Probably the best of such means is a controversial atmosphere; a great many of the well-known competent octogenarians have been statesmen and others who are concerned with

the strife of ideas. In the case of any individual old person, upon the kind of life he has been leading or wishes to lead will depend the most suitable methods of preventing apathy and lassitude. Imperial and local politics may suit some; letters to the local paper, lectures, the secretaryship or treasurership of clubs may befit others; anything, in fact, which keeps the brain well flushed with blood, especially if it necessitates going out of doors, should be encouraged. Indoors, acrostics, crossword and other puzzles, and the like, are very useful. The one thing to be avoided is the somnolent arm-chair by the fireside.

The periodical physical overhaul advocated above should be conducted not with a view to bringing an old man's life into agreement with academic canons, but with the object of warding off probable dangers and discomforts. Violent and drastic changes should not be attempted; it is far better to continue a stupid thing which has succeeded in this individual case, than to inaugurate a wise thing which has never been tried. A very important item in any overhaul is a thorough examination of the eyes by an experienced specialist, for upon the easy working of the organs of sight will depend a good deal of the comfort and contentment of those whose physical activities are necessarily restricted.

The Ears and Nose

Another pair of organs which deserve very careful supervision as old age approaches are the ears. Deafness is the most irritating, as blindness is the most tragic, of the penalties of old age. It is probably true that some of the deafness from which old people are said to suffer is due to inattention, but even allowing for this there remains a number of people in whom some definite impairment of hearing takes place after sixty-five years. When such impairment is accompanied by ringing or singing in the ears, the position is a pathetic one because there is no known cure. A periodic investigation by a really competent aurist would possibly mean that the tendency to increasing deafness and development of singing in the ears might be arrested, but even this cannot be assured. There would, however, be less deafness in age if people in health would give to rubbing, drying, and massaging the ears more attention than the majority now do.

There would certainly be fewer infections of the upper air passages if the same people would be more attentive to the question of the general hygiene of the nose. In old people, because of their blunted reactions, this is especially needful. The microbic invaders entrench themselves before the keepers of the house have roused themselves to the necessity of defence, with the result that a catarrhal condition arises which, beginning with the nose, spreads gradually downward until it reaches

the bronchial tubes, a position from which it is, especially in winter, dislodged with great difficulty. Every old man should be taught to wash the inside of his nose whenever he washes his face. A soapy little finger insinuated up each nostril and moved gently round and round will do all that is necessary in provoking a flow of cleansing mucus, and if it should cause a hearty sneeze or two, so much the better. In towns this little rite should be observed as a routine measure every night and morning. In times of epidemic, during and after railway journeys, in dry weather when there is much dust about, it is well to supplement the soap and water regime by treating the inside of the nostrils with one of the numerous vaporizing ointments now on the market, containing antiseptic oils, specially prepared for this purpose.

The Teeth

Inasmuch as nearly all those who arrive at old age have shed most of their teeth on the journey, the mouths of the aged are seldom such as to call for more than a passing curiosity. It is, however, well to remember that buried stumps may suddenly and without any warning give rise to a great deal of pain, so that an X-ray examination of the sockets should always be made where there is any difficulty in tracing the cause of a facial neuralgia.

Acidity

The most pronounced chemical characteristic of old age is the tendency to acidity. When foods turn acid it shows that the normal chemical balance is upset, demanding a revision of the way of life in general, and of the dietary in particular. The usual manner of dealing with slight degrees of this aberration by taking alkaline tablets, such as soda mints, is a very good one. Indeed, the taking of alkalis of this kind should not be reserved for the cure of symptoms of acidity, because old age may be said to be a condition of chronic acidity, in which alkalis like soda, potash, magnesia, bismuth, and various others, taken under proper supervision, often serve to keep unpleasant manifestations at bay.

General Aspects of Old Age

Since the days of the author of Ecclesiastes (and he was not the first) many profound sayings have been uttered on the various aspects of old age. Some of these are not complimentary, as this from Cicero: 'Great age enfeebles the memory, and yet I have never heard it said

that an old man has forgotten where he has hidden his treasure. He remembers vividly all that interests him. He well knows to whom he has left his land, who are his creditors, and above all who are his debtors.' That, however, is mild in comparison with Dean Swift's characteristically savage contribution already cited.

In another and kindlier atmosphere are Bacon's comments:

Men of Age object too much, Consult too long, Adventure too little, repent too soon, and seldome drive Businesse home to the full Period, but content themselves with a mediocrity of Successe. . . . Age doth profit rather in the Powers of Understanding, than in the Virtues of the Will and Affections.

The following is from Sir James Paget, a great surgeon and scholar of the mid-Victorian period:

It is very difficult for an old man—say for one over seventy and not unhealthy—to observe all the changes which in the passing years are in progress in him. Even in many things which we can feel and see and which are certainly changing in him he may be unable to discern the change. No man over seventy walks with the same pliant elastic step as he walked at thirty or forty; but many, over seventy, I think are not conscious of the change; they see it in others, they cannot feel it in themselves. Any one I suppose discerns the difference in voice and speech in a friend over seventy while he remembers what it was twenty or thirty years before; but to the old man himself I suspect the change is often imperceptible. He does not observe the diminished range of notes or the veiled sound of his S, or worse still, its shrill whistle. It is only when he puts these and the like things to a careful test that he finds the change. He may find it by timing his walks—his full speed may be half a mile less in the hour—or by trying his voice—he cannot reach his former highest or lowest notes or sustain any note as long as he could. And so it is throughout; the change has been so gradual that it is only with care that even the accumulated contrast can be discerned. With such care the changes can be seen, and so can the reasonableness of the diminution of practice. Herein is one of the many things in which the old need education as much as the young do; they need self-examination, self-teaching. The 'I will' is, in many of their designs, slow and hesitating and procrastinating. Their word should be 'I will, now,' and the work should follow instantly.

Here are some further maxims, appended by Dr. (formerly Dean) Inge to an article on 'Old Age,' in 1930.

The tragedy of growing old is remaining young.

The deeds of the young, the counsels of the middle-aged, the prayers of the old.—GREEK PROVERB.

Your old men shall dream dreams, your young men shall see visions.—JOEL.

Old men like to give good advice; it consoles them for being no longer able to give a bad example.—LA ROCHEFOUCAULD.

But at my back I always hear
Time's wingèd chariot hurrying near,
And yonder all before us lie
Deserts of vast eternity.—ANDREW MARVELL.

Old Age hath yet his honour and his toil.—TENNYSON.

Warte nur, balde,
Ruhest Du auch.—GOETHE.

The Good man feels old age more by the strength of his soul than by the weakness of his body.—SIR THOMAS OVERBURY.

But go thy way till the end be; for thou shalt rest and stand in thy lot at the end of the days.—DANIEL.

PART FOUR

EVERYMAN IN SICKNESS

I—DISEASES AND THEIR CLASSIFICATION

DISEASES are not so many separate things, like tables and chairs; but disturbances of bodily harmony, brought about by all sorts of abnormal circumstances, external and internal. Most of the names given to our various forms of illness have an ancient history, dating from days when diseases were commonly looked upon as so many demons that entered into us and possessed us. Medical nomenclature is consequently very confused, and the confusion of terms is responsible for no small part of the muddled thinking about disease which is almost universal among the lay public, and far from absent from professional minds. Probably, it would be a good thing if we started afresh with our classification of physical and mental disorders, basing this on our present knowledge rather than on a blend of that knowledge with the speculative and superstitious guesses of our ancestors. To the modern scientific physician, words like 'rheumatism' and 'biliousness' mean very little. Lots of terms like these are used every day merely as a cloak for ignorance, or an excuse for inertia. If we acknowledged this it would not so much matter; but, unfortunately, we all of us are apt to assume that when we have once attached a label to a thing we have said all that is necessary about it. An example or two will show how confused our grouping of diseases really is. We speak of a person as suffering from tuberculosis, no matter whether the special locale of his disorder be the lungs, or the hip-joint, or the abdominal glands, on the ground that the peculiar agent responsible in each case is a specific germ known as the tubercle bacillus. Yet another patient we describe as suffering from rheumatoid arthritis, because certain of his joints are inflamed; though the causation of such inflammation may cover a wide range. The symptom 'anaemia' we commonly speak of as a specific disease, though every modern doctor knows that, like headache, it may be but one manifestation of any one of a large group of pathologic conditions, running varying courses and having entirely different origins.

More and more doctors are coming to see that it is only secondarily and as abstractions that they are called upon to contemplate the various syndromes, or groups of symptoms, which are popularly spoken of as 'diseases.' They are recognizing that their first task is to deal with, and to investigate, the general disharmony existent in a diseased individual man, or woman, or child. Any method of grouping diseases, as botanical or geological specimens are grouped in museums, is bound

to be more or less unsatisfactory, unless we realize that such classification has been made purely for the purposes of temporary convenience and temporary expediency. The wise physician lays before himself these questions: 'Is this patient confronting me a sick man? If so, where lie his more immediate dangers? Where are the weak points in his armoury; and how best, with my limited knowledge, can I strengthen them? Is his illness due mainly to some abnormality in external circumstance; or to some peculiarity or weakness in his powers of adaptation? Which of these can I counter or support most effectively?' All the doctor's examinations, all his questions, and all his often seemingly irrelevant investigations, have as their object the discovery of facts which will help him to solve these problems. The art of medicine is not just a matter of finding a name for an illness, and prescribing for it some stereotyped remedy. For nearly all forms of illness there are no stereotyped remedies; and it is one of the purposes of this book to disabuse the public mind of the notion that the palliation of bodily or mental disorder can be brought about by the application of tabulated knowledge, such as might be inscribed on a chart, pinned to the door of a domestic medicine cupboard. Only by an understanding of the main principles of human physiology and psychology, and by the employment of an informed intelligence, can we hope usefully to intervene in those aberrations from bodily and mental harmony which we call disease.

II—THE DOCTOR'S TECHNIQUE

WHEN we visit the doctor most of us feel like aliens in a strange land; mysterious things take place, the significance of which we scarcely attempt to fathom; questions are asked the bearing of which eludes us. Yet the more curious of us must sometimes speculate as to what it 's all about, and even wonder whether it is not all so much mumbo-jumbo—the medicine-man up-to-date.

What is it that the doctor is trying to do? What is he trying to find out? What do we expect of him? And what does he regard as his specific task? He feels our pulse; he looks at our tongue; he taps his finger on our chest-wall; he applies his stethoscope to the region of our heart, and to that of our lungs; he adjusts an inflatable bag round our arm, squeezes a rubber ball, watching a moving dial as he does so; and so on. In the first place he wants to find out whether our suspicion that all is not well with us is justified; for many people imagine that they are ill, or are going to be ill, merely because they do not feel happy or content. He wants, also, to find out, and to trace to its origin, any defect in the functioning of one or other of the ruling organs of the body. Has the balance or equilibrium of the body been upset, and, if so, how? Is equilibrium on another level being gradually established, and, if so, should that readjustment of levels be assisted or, if possible, checked and corrected? Is medical intervention in the sequence of events likely to be effective and, if so, at what point of the vicious circle can it be best applied? The state of the tongue; the regularity or irregularity, hardness or softness, quickness or slowness, of the pulse; the blood-pressure as shown by the sphygmomanometer; the sounds of obstruction or back-working through a defect in any one of the valves of the heart; the size of the heart; the dullness or resonance of the various parts of the chest wall when percussed by the finger; the temperature of the blood: all these things have a meaning to the doctor, who, using the fruits of his own experience and the accumulated knowledge of generations of his professional forbears, is enabled therefrom to form some idea of where and how the physiological processes of his patient have departed from the normal.

Only in so far as the doctor has succeeded in forming a just picture of physiological aberration can he be said to have diagnosed a case. For true diagnosis—that is, understanding—does not consist merely in giving a name to the disorder—rheumatism, dermatitis, arthritis, or what not.

Modern diagnostic methods are often much more elaborate than those which every conscientious doctor employs at his first interview with a patient. Where doubt or suspicion arises in his mind he examines, or arranges for some specialist to examine, the interior appearance of the body by means of the X-rays. He has the blood examined microscopically, bacteriologically, or chemically, or possibly all three. Maybe it is expedient to examine the sputum for bacilli, or the stomach contents to determine their degree of acidity; or the urine, in order to find out if it contains sugar, or albumen, or other abnormal ingredient. Various tests, manual and electrical, may be employed to learn if the nerve mechanism is in order. Elaborate psychological investigations may be carried out to discover some emotional perversion and to trace it to its source. All these findings it is the business of the doctor to put together, and from them to construct in his mind a picture of what has really gone wrong with his patient. Having determined this, so far as his knowledge and opportunity permit, it is his further responsibility to decide what, with our present knowledge, can be, and should be, done to mend matters. Often, unfortunately, what Nature and ignorance have done, the doctor cannot undo; it is then his task to devise means whereby the evil that cannot be cured may, to some extent, be relieved or lessened. This is where experience tells—even more than it does when a doctor is confronted with an illness for which science has placed in his hands a specific remedy. It will be seen how impossible it is, in any but the simplest form of disorder, for the uninstructed layman to attempt to doctor himself. Far more often than not, in his efforts to relieve some outstanding symptom, the amateur is likely to hinder the very forces that are working towards his recovery.

III—THE IMPORTANCE OF A PERIODIC OVERHAUL

IF one takes even a general interest in health matters one can hardly fail to recognize the supreme importance of early diagnosis and treatment. Much illness can be traced back to some minor deviation from the path of absolute healthiness, due possibly to the failure to observe fully some simple rule of hygiene. It should be unnecessary, then, to suggest the importance of periodical medical examination, with a view to receiving either an assurance that all is well, or a timely warning of possible danger. In theory, we probably all agree with this, but in practice we very rarely do it. In this country most medical practitioners would say that for a patient to present himself for overhaul when he felt well was almost unheard of, and that his appearance in the early stages of non-acute disease was comparatively rare.

Except perhaps with regard to children we appear to have lagged behind some of our contemporaries in this matter of examination of the healthy for preventive purposes. We may in apparent health present ourselves for examination for some other purpose, such as life assurance, or admission to one of the public services. The fact that many such candidates discover to their surprise that they do not come up to standard is ample proof that absence of appreciable symptoms is no guarantee of a satisfactory condition. In America, some twenty years ago, the leading insurance companies started a system whereby free medical examination from time to time was available for the holders of their life policies. This was done purely as a business proposition, in the belief that it was possible by this means to increase the length of life of at least some of their clients. The results appear to have justified the procedure, for it is being extended. Germany, Switzerland, Japan, and many other countries have followed the example.

It is true that in this country at least two insurance companies have similar schemes, and others give certain aids to treatment, but it can hardly be claimed that the idea of periodic overhaul has been generally accepted, and there is much to be done in bringing its importance before the public. It must of course be realized both by the layman and by the medical profession that an examination of this nature is valueless unless it is thorough. A cursory examination following the patient's statement that he feels well would be not only useless, but dangerous, as it would give a false sense of security. There must be an extensive

examination of the different systems of the body, following a careful inquiry into the patient's medical history. The full and honest co-operation of the patient is also essential. Should he yield to the temptation to secure a favourable verdict by minimizing symptoms and past troubles he would defeat his own object.

For children we do this thing reasonably well, and the theory receives fairly general acceptance. In every district in this country Child Welfare Centres are available where children may be taken not for treatment, but for inspection. If it is found that the infant is failing to gain weight or to take nourishment properly, or that it shows signs of being unwell, or below standard, suitable advice on management is given. Where active treatment is required the child is referred to the family doctor or to a hospital. In this way prevention may be secured in good time.

It is noticed that, as the children reach the age of from two to five years, attendance at the Centres tends to ease off, but efforts are now being made to bridge the gap between attendance at the Centre and attendance at school. When school age is reached the children at State-aided schools come within the purview of the school medical service. In most districts routine school medical inspections are made at entry, at eight years of age, and when the time of leaving school is approaching. Special examinations of delicate children are made more frequently.

In the County of London in 1933, 39% of the children examined were referred for some form of treatment. If one excludes those requiring dental treatment only, the percentage was sixteen. 4% were referred for specialist examination of tonsils and adenoids, but less than half of these required operative treatment. The figures relating to enlarged tonsils are falling each year, showing an increasing avoidance of operation except where it is essential. This is important, as critics of the system often allege that routine medical examination gives rise to unnecessary treatment. Defects of vision are frequently found, and early treatment obviates the risk of continued strain, and of the defect gradually becoming more serious. Early tuberculosis, early heart trouble, rheumatism, and chorea are often detected. Spinal curvature and other postural defects which have escaped the parents' notice are also discovered and treated by remedial exercises.

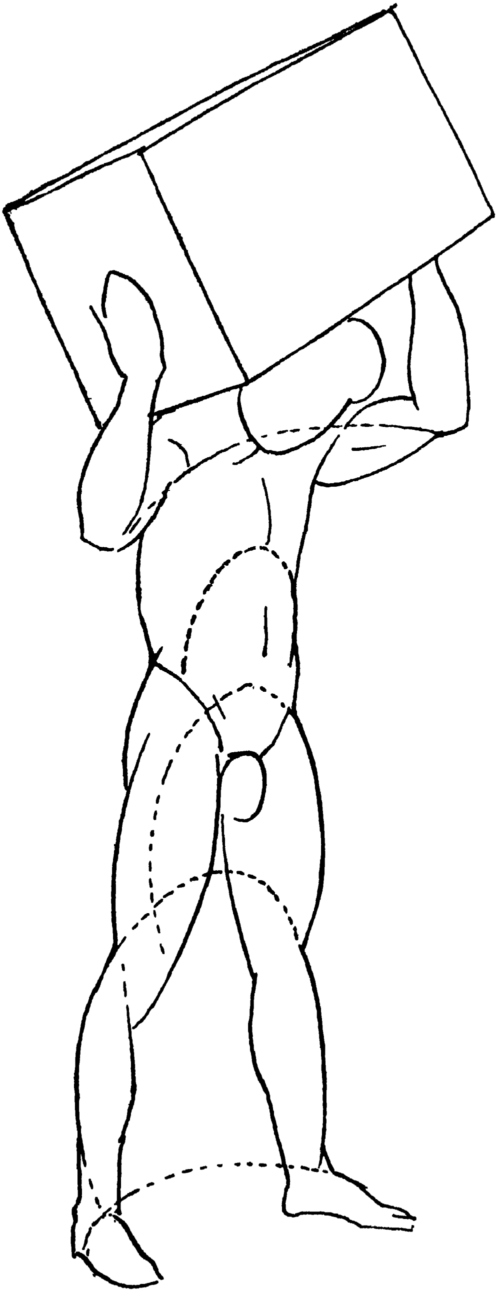
The correction of even minor defects in the developing child is of obvious importance to its future health, but there is no reason why we should stop there. Few of us are so perfectly made that all the different systems of our bodies stand the strains of life equally well, and routine examination applied to the adult, perhaps particularly after forty, may have a notable effect on longevity.

The examination of two groups, each of about three hundred business

men in New York and Boston, gave closely parallel results. Only about one in a hundred had no discoverable defect. Others needed only observation, or instruction in the rules of hygiene. But in 60% of cases defects were found which if uncorrected might affect the length of life. Another 15% fell into a still more serious category, having advanced conditions, which, in some cases, were in urgent need of treatment.

The acute diseases usually come in good time to the notice of the physician. It is the insidious chronic diseases which are so often undetected or ignored by the patient, and it is these diseases which could often be held in check fairly easily if treatment were started in time. Many heart troubles, for example, may cause little harm if the life is so regulated that sufficient compensation is possible, and undue strain is avoided. Diabetes is not at present a curable disease; but it can be kept in abeyance with insulin treatment combined with a dietetic regime which has been made less irksome to the patient than formerly. Urine examination may reveal the presence of diabetes, or of imperfect functioning of the kidneys. Blood-pressure estimation may show that old age is advancing more rapidly than it need.

In spite of considerable success in modern methods of treatment for tuberculosis and cancer, these diseases are particularly difficult to bring to treatment in the all-important early stages. To the popular mind these names both suggest a death sentence, and many patients will do their best to conceal symptoms suggesting these troubles. Concealment will not stay the disease, and it cannot be too widely known that if they are detected in time many cases of these two diseases can be cured or at least arrested. Probably nothing would bring these hidden dangers to light so effectively as would routine medical examination, with a determination on the part of patients to learn the facts and to take all possible steps to remedy defects.



THE ARCHES OF SUPPORT

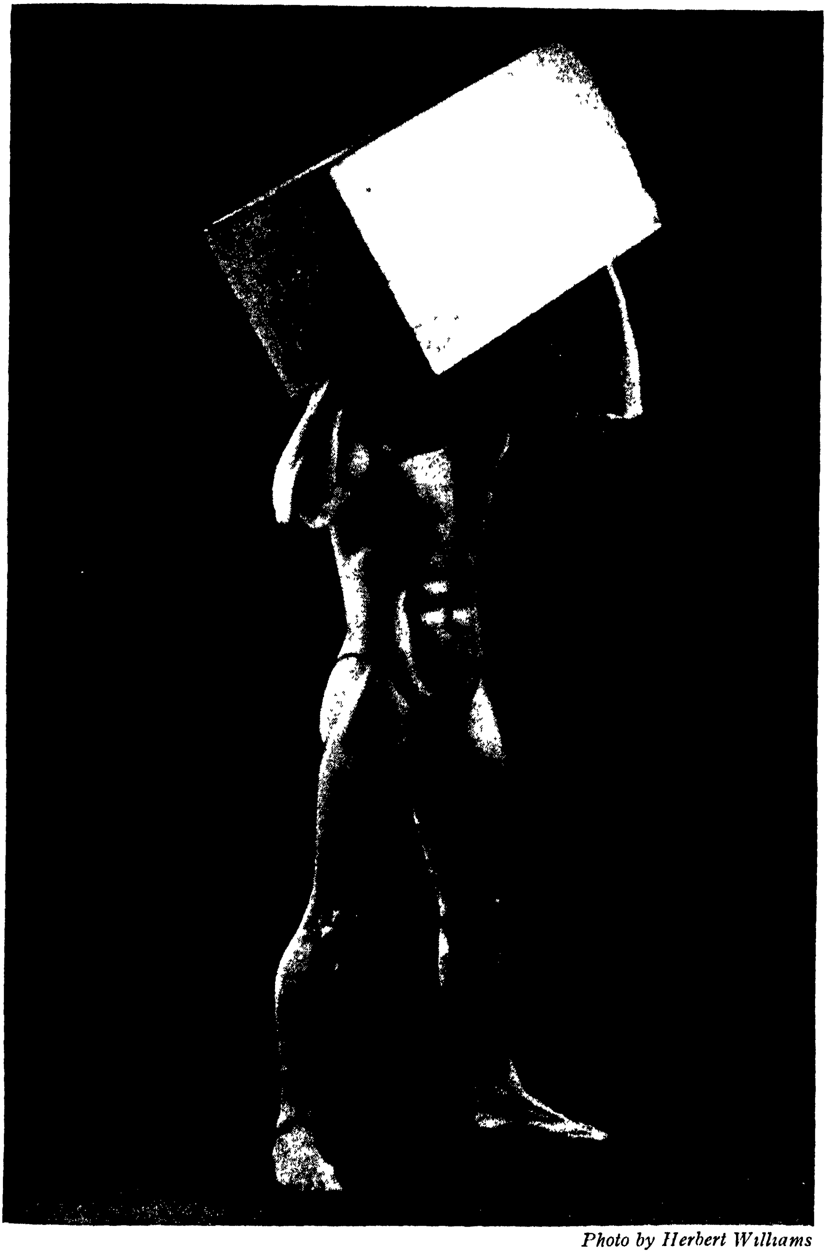


Photo by Herbert Williams

THE ARCHES OF SUPPORT

Shows equal balance on the two feet, with the centre of gravity exactly between them

IV—IMMUNITY, NATURAL AND ACQUIRED

That, with or without external treatment, some people recover from illnesses which to others prove fatal, is a fact obvious to every one. This selectivity is not a mere matter of environment, or of worse or better general health; but is, as we say, specific. Some people are relatively 'immune' to this or that disorder, whilst others are in varying degrees susceptible to it. Then, again, there are many diseases—mostly germ-caused—one attack of which prevents its victim, if he recovers, from falling ill with the same ailment again; either for life, as in smallpox, or for a considerable period of time, as in diphtheria, even though he may be exposed to infection. Naturally enough, it has for long been the endeavour of those engaged in medical research to discover the nature of those protective agencies which operate in some people, but not in others. It has been said above that this variation in immunity is specific; that is to say, it applies to a particular disease, or to particular diseases. An attack of smallpox affords protection against a second attack of that disorder; but it offers no protection against measles, or diphtheria, or tuberculosis. It is still an open question whether specific immunity is always acquired after birth, or whether it is to some extent inherited. Almost certainly there is an inherited factor. It is clear that if we thoroughly understood what it is that happens within us to bring about a natural recovery from disease, we should be in a much stronger position for conducting our fight with illness. It is because we have learnt something of these natural recuperative forces, that many of our recent successes in medicine have been won.

Many of the serious as well as many of the slighter diseases that afflict mankind are caused by poisons produced by other living organisms. For the most part these are tiny, microscopic plants or animals, popularly lumped together as 'germs'; though in India, and in certain other parts of the world, the poisons produced by larger creatures such as snakes are responsible for a number of fatalities. The whole world teems with parasitic germs; and, at every moment of our lives, numbers of these find entrance into our bodies. Had we no natural defences against their peculiar attacks, we could not possibly live on this planet; for to avoid them were an impossibility. In this connection the first thing that strikes one is that, from the attacks of many kinds of germs, all men are immune. No matter how much we may be exposed to

potential infection, we do not hear of men catching distemper from their dogs; nor, indeed, do we hear of dogs or horses contracting measles or scarlet fever.

Many diseases, however, are common to more than one species of animal, though the symptoms may be very different. Thus, infection with certain germs provokes in some animals the production of neutralizing substances or anti-bodies identical with and similar to those which a corresponding infection provokes in man. This fact has been made great use of in medicine. Perhaps the best example is afforded by the diphtheria bacillus. Thus it is found that the injection into a horse of the toxin prepared from dead diphtheria bacilli causes its blood serum to be charged with anti-toxins. If some of this serum is drawn off and injected into a child suffering from diphtheria, the child's own resistance is enormously increased. The immunity thus effected is known as passive immunity, to distinguish it from that active immunity which results from the patient's own production of anti-bodies in response to infection. These anti-bodies, whether actively produced or passively received by injection, usually remain in the blood for a variable period of time: and it is found that races, both of men and of animals, can, by repeated attacks of a germ disease, become less and less susceptible as the generations pass. To take a striking example: since the introduction of plague into Bombay in 1896 the rats of the city, at first stricken wholesale by the disease, have annually shown progressively lower susceptibility thereto. Experiments over a period of years show that a given dose of plague bacilli will to-day kill less than one-fifth the number of Bombay rats than were killed by a similar dose twenty-five years ago.

It should be noted that active immunity usually lasts much longer than does passive immunity. In order to bring about active immunization, it is not usually necessary to inject the living germs themselves. It is generally sufficient to inoculate with a preparation of their dead bodies, or of the toxins which they have produced outside the body. In a few cases, however, this has not yet been found effective; but the potential dangers of injecting living disease organisms, whether bacillus or ultra-microscopic virus, are obvious.

The immunizing agent usually tends both to neutralize the bacterial toxin and in some way so to act on the living germs as to make them more readily incorporated—physiologically or pathologically—with the phagocytes. Luckily, the anti-toxic factor can often be provoked into existence by the inoculation of a virus so altered and attenuated as to be incapable of producing the actual disease. Anti-diphtheria serum is thus obtained, and has proved of enormous value both in treatment and in prevention. As already mentioned, the blood serum of a horse, having, consequent on a series of steadily increasing doses of virus,

become heavily charged with the anti-toxic factor, is injected into a susceptible or infected person; and produces in him a temporary 'passive' immunity. So heavily charged with anti-bodies may the animal's blood become that its tolerance for the specific toxin can be increased from ten thousand to one hundred thousand times. The state thus induced in the animal is spoken of as 'active' immunity, and corresponds fairly closely with the immunity brought about by an attack of the disease itself. Prophylaxis of rabies, smallpox, typhoid, and paratyphoid is effected in this way.

Not only passive, but also active, immunity to diphtheria may be induced in susceptible children by the injection of a mixture of diphtheria toxin and anti-toxin. The immunity thus conferred lasts for several years. By a method known as the Schick test—which consists in injecting into the skin an infinitesimal amount of diphtheria toxin, and observing whether or not a redness appears round the injection point —the susceptibles may be separated from the insusceptibles, the former alone needing to be artificially immunized.

Similar tests have been devised for the detection of tuberculosis and of scarlet fever (the Dick test); whilst other diagnostic tests, physiologically similar in principle, are the Wassermann test for syphilis, and the Widal test for typhoid.

V—GERMS AND INFECTION

GERMS have been given various names, such as bacteria, microbes, bacilli, and micro-organisms. It does not matter much which word we employ, so long as we know what we mean when we use it. Germs are generally considered to belong to the vegetable and not to the animal world. Yet they live not quite like vegetables nor yet quite like animals. For example, they do not possess chlorophyll, which gives the green colouring to plants; on the other hand, they do not reproduce themselves like animals. Perhaps it is best to regard them as existing on the border line between the animal and vegetable kingdoms.

They are the smallest of living organisms (if we exclude the filter-passing viruses—of which we shall speak later); the width of an average germ being one twenty-five-thousandth of an inch and the length about one five-thousandth of an inch. They can be seen only under the microscope. Each germ is a single cell, but it differs from other kinds of cell in having no nucleus: it is just a minute mass of protoplasm enclosed within a cell wall. In shape germs may resemble very small spheres (cocci), straight rods (bacilli), or curved or twisted rods (vibrios, spirilla). Often the rods become stuck end to end, forming chains or filaments. Some germs have little whips (flagella) at either end, which lash to and fro and enable them to move about; or these flagella may stick out from all sides of the germ.

A germ reproduces itself by dividing into two equal halves, but there is evidence that some form of sexual reproduction does also take place. In favourable conditions multiplication is very rapid, and hundreds of thousands of single cells can be produced in a few hours. The life of a germ is very short, lasting generally less than half an hour. It can live, however, in a sort of state of suspended animation for a year or longer. This it accomplishes by forming round itself a tough envelope which enables it to resist extremes of heat and cold as well as desiccation. The spore of the anthrax bacillus, for example, which causes a deadly disease in sheep and oxen, and can also infect man, must be subjected to dry heat at a temperature of 140° C. for several hours if it is to be killed with certainty. When the spore finds itself in a suitable environment, with the right temperature, moisture, and food supply, it wakes up, throws off its tough resistant envelope, and enters upon a life of unbridled bacterial activity.

Germs exist everywhere—in ponds and ditches, in streams and rivers, in refuse heaps, bogs, and drains, in the soil and in the sea. If any

organic matter is allowed to stand exposed to the air it soon swarms with germs which quickly set to work to break it up. Germs are first-rate housebreakers. Paper, rags, straw, leaves, and wood are decomposed and broken down by the bacteria which attack cellulose, and the decomposition of dead bodies is carried out by others. Thus the elaborate chemical compounds which have been built up during the life of an organism are at death reduced by germs to their original simpler forms, which can once again be utilized by new generations. Chemically speaking, bacteria put the dead body back to where it came from. Their ways of living and feeding are little short of astonishing. They break nearly all the rules which other living organisms have to obey if they are to survive. Many of them can live without oxygen; some, in fact, will die if they are exposed to it. Some get their energy by oxidizing sulphur or iron or ammonia; others, by splitting up organic matter.

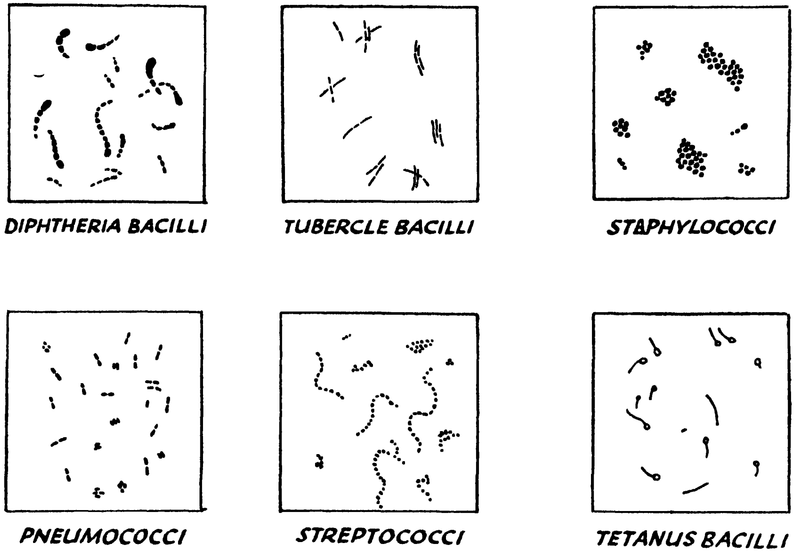
Germs that are Useful

Germs are commonly looked upon as being only harmful and hostile: but such is far from being the case. We have already seen that they perform a very useful function in redistributing the chemical elements of dead organisms and waste matter. In addition to this, bacteria play an essential part in the fermentation processes employed in manufacture; as, for example, in the tanning of skins, in the preparation of indigo, and of tobacco and hay. Bacteria are necessary in butter-making and in cheese-making; but more important than these activities are those exerted by bacteria on behalf of the farmer. Hundreds of thousands of tons of urea are deposited daily in the excreta of animals and man. The manure which the farmer spreads over his land would be of no benefit to the soil if certain bacteria were not able to break down this urea into nitrites and nitrates, and thus make its nitrogen content available to plants. There are bacteria which can collect and 'fix' the nitrogen in the atmosphere. These are found in the nodules on roots of leguminous plants (peas, beans, vetches, etc.), and it has been found that sowing land with these plants leads to a great enrichment of the soil with nitrogen. For this reason leguminous plants are an essential item in the rotation of crops.

The Discovery of Germs

The microscope was invented in the sixteenth century, and has made possible the development of bacteriology, or the science of germs. A Dutchman, called Van Leeuwenhoek, who used to write long rambling letters to the Royal Society of London, in the seventeenth century detected bacteria in scrapings from his own tongue, but it was not

until the nineteenth century that knowledge about these mysterious one-celled organisms began to accumulate. And it was only about sixty years ago that it was definitely known that bacteria had any connection with disease. For centuries it had been realized that disease was contagious, and could spread from person to person, and in time the supposition was put forward that actual infective material passed from one person to another. What this material might be was another



SOME TYPES OF GERMS

and more difficult question. A German physician, Henle, born in 1809, came to the conclusion it was living matter. Finally, the triumphant researches of the Frenchman Pasteur and the German Koch proved once and for all that infection is associated with germs.

Pasteur exploded the myth of 'spontaneous generation' of microbes. He proved that fermentation is a physiological process by demonstrating that the yeast which caused fermentation consists of living organisms, capable of growth and multiplication. He showed that the disease which threatened to ruin the silkworm industry in France was brought about by a germ. He told the wine growers that if they heated their wine to a certain point it would not spoil, as wine 'sickness' was due to a microbe; from this we get the word 'Pasteurization,' applied to a process of sterilization by heat.

When he succeeded in curing patients of hydrophobia by inoculation, the whole world went wild with enthusiasm, and the Tsar of Russia sent him a diamond cross of Saint Anne, and one hundred thousand

francs with which to begin the building of what is now known as the Institut Pasteur.

It was Robert Koch, however, who, carrying on most elaborate research work in spare time snatched from a busy general practice, put the germ theory of disease on a really scientific basis. The conditions which have to be fulfilled before it can be stated beyond doubt that a certain germ causes a certain disease were laid down by Koch. The organism, he said, must be discoverable in the infected animal or man in all cases of the disease; it must be cultivated through several generations on an artificial medium; the cultures must be able to reproduce the same disease when brought into contact with animal or man, from whom the same organism must be again recoverable in pure culture. The work that brought Koch from the obscurity of a general practice to the fame of a scientist with a world-wide reputation was his research on the anthrax bacillus, the results of which were published in 1876. These bacilli he found in the blood of infected animals, and he was able to grow them outside the body. From the culture of organisms obtained in this way he produced the disease experimentally in other animals. Koch also observed the formation of spores in anthrax bacilli. Thus the germ theory of disease was put on the pathologic map.

Koch was soon given a scientific post in Berlin, and he continued to make important contributions to bacteriology. In 1882 he discovered the specific germ of tuberculosis—the tubercle bacillus—and, later on, that of cholera, a germ called the cholera vibrio. He was awarded the Nobel prize for medicine in 1905, and when he died in 1910 he was recognized as one of the greatest bacteriologists the world has seen.

Since the days of Koch and Pasteur the science of bacteriology has gone ahead by leaps and bounds. The fear has even been expressed that the germ theory of disease has lately too much dominated medical thought. While this may be partly true, the benefits gained from those discoveries of little more than sixty years ago have been enormous. The amazing advances of modern surgery have only been made possible by antiseptic and aseptic methods which have gradually been built up on the basic assumption that infection of wounds is brought about by germs. Modern sanitation, the purity of our water supply, and the control of such diseases as typhoid, cholera, malaria, diphtheria, and others, we owe to Koch and Pasteur, and to the workers who followed them.

Methods of Studying Bacteria

We have already mentioned the criteria laid down by Koch for the establishment of a causal relationship between a particular germ and a particular disease; so that it may be asserted with scientific confidence

that, for example, typhoid fever is associated, and always associated, with a bacillus having a definite shape and form and certain constant characteristics distinguishing it from other germs. So it is called the typhoid bacillus. Before the scientist can prove this, he has, first of all, to catch his germ. He has to isolate it from other germs, to bring it up on artificial foods in his laboratory, so that he can study its way of life—how it behaves chemically and physically—and he has to devise various means of making it easily visible under the microscope. He has to establish the identity of the numerous germs that exist, and to lay down standards by which any other observers can distinguish one germ from another.

Koch did some extremely important work in this business of identifying and examining germs. His publications on the staining of bacteria with aniline dyes in order to make them visible under the microscope, on photographing them for purposes of identification and comparison, and on growing (culturing, as bacteriologists call it) bacteria on a solid medium of gelatine and broth, were of the most profound significance in the science of bacteriology.

Artificial Culture of Germs

In growing disease germs outside the body it is evident that their food should resemble as far as possible the kind of stuff they feed on naturally; so it is that coagulated serum of blood is often employed as what is called a culture medium. Koch used this serum for cultivating the tubercle bacillus. It has been found that various media, consisting of proteins or carbohydrates, will support life in most of the disease-producing germs; and meat extract, gelatine, and broth, a carbohydrate substance called agar (which is often mixed with other substances), potato extract, and a variety of other preparations serve as fodder for the germs kept in captivity in the bacteriologist's laboratory. The advantage of having different media is that a particular microbe may grow well on one medium and not on another, and this helps the scientist to identify it. Also, each microbe, as it feeds, breaks down the various substances on which it lives into gases, acids, etc., in such a way as to distinguish it from others. Some microbes, for example, ferment sugars, whilst others do not. Some have a destructive action on blood, and others, again, do not.

Of course, before these media can be used, they must be sterilized in order to kill any bacteria that may already be present in them, otherwise the bacteriologist would not be able to tell whether the bacteria that appeared were those he had put into the media. Koch used to sterilize his media by heating them in steam at 100° C. By sterilizing with steam at high pressure in a special apparatus higher temperatures still

can be obtained. Another method of sterilization is to pass the fluid through a filter whose pores are so small that bacteria are unable to get through them.

The modern technique of bacteriological investigation is, roughly, as follows. Let us suppose that you have a sore throat, and that your doctor wants to find out what germs are responsible for the inflammation of your tonsils. He will take a swab—a piece of sterile wool wrapped round the end of a stiff wire—and rub it against the inflamed tonsil, so capturing some of the inflammatory matter. He will then smear this on the surface of a solid culture medium (say agar or gelatine, contained in a glass tube), which he will incubate at the temperature of the body, that in which the germ is accustomed to live. Within a certain number of hours he may see a whitish round patch on the surface of the medium. This patch consists of the thousands of bacteria which have grown and multiplied, and is known as a 'culture.' The doctor can then take a portion of this patch on the end of a platinum wire, spread it over a thin glass slide, and examine it under the microscope. This is the simple kind of procedure adopted in diagnosing diphtheria; for the bacillus associated with this common disease is relatively easy to identify under the microscope. In various circumstances the doctor may wish to look for germs in suppurating wounds, in the expectoration, in the blood-stream, in effusions of fluid into the joints and the cavities of the body, in urine, faeces, etc. He does this by inoculating different media with these secretions and excretions of the body.

Before the doctor looks through the microscope for the germ, he usually stains it, so that it may be easily visible. This is another of the methods worked out by Koch, who found that bacteria had a marked affinity for aniline dyes. Germs stained with these various colours are much easier to see under the microscope—in fact, one could not see some of the smaller types without first colouring them. An interesting fact is that certain germs have a particular liking for some dyes, and a distaste for others. This provides still another way of differentiating various types.

In the chapter on immunity an account is given of the way in which the body mobilizes its defences against attack by germs. We there learnt that each germ provokes the formation in the blood-stream of anti-bodies specially designed to overcome it. Without going into technical details, it is sufficient to state that this reaction, and others associated with it, can be turned to account by the bacteriologist in deciding whether a patient is infected, or has been infected, by a particular microbe. In a given disease the doctor may be unable to identify the causative germ. If, however, he finds that the anti-bodies of a suspected germ are present in the blood of his patient, then he can safely assume that the germ is present also, although he may not be able to find it. This is, of course, of considerable importance, and is of

great value in diagnosing typhoid, paratyphoid, and syphilis. The Wassermann test for syphilis, which, roughly speaking, is based on the above principle, is one of the most valuable of laboratory tests.

Organisms Smaller than Germs

Do living organisms exist that are still smaller than the bacteria we have just been discussing? The general opinion is that they do, although, as anything smaller than bacteria is still extremely difficult to investigate, we cannot yet determine the truth of the matter with that degree of exactitude which science demands. Particles smaller than the smallest known germs are outside the range of ordinary microscopic vision.

It was observed in 1893 that if the fluid from a blister of an animal suffering from foot-and-mouth disease was passed through a filter the pores of which were too small to let bacteria go through, the disease could still be conveyed to animals from the fluid thus filtered. The process was repeated, and the disease transmitted through a succession of animals. In other words, an infectious disease had been caused experimentally by some 'thing' which was not a visible germ. This infectious poison, or virus as it is called, was given the name of filter-passing virus. One of the filters commonly employed for this purpose is made of unglazed porcelain, the holes in which are so small that bacteria cannot pass through them; the filtrate therefore being free from bacteria. This provides a way of separating the poisons or toxins excreted by bacteria from the bacteria themselves.

With ordinary microscopic methods light is transmitted directly through the material to be examined, and so direct to the observer's eye; but it is difficult in this way to see very thin or very small microbes. It is, however, possible to extend the limits of microscopic visibility by the method known as dark-ground illumination. Here, the illumination is so arranged that the light strikes obliquely from all sides on the material to be examined, and does not pass direct to the observer's eye. Let us suppose this material to be a wet film containing very small particles. The particles will scatter the light and show as brilliant images against a dark background; and, in this way particles smaller than bacteria can be seen. If ultra-violet rays are used as a source of illumination and a camera is substituted for the observer's eye, still smaller particles can be observed. It has been calculated that by this method the form of a particle as small as somewhere in the region of one hundred-thousandth of a millimetre can be determined.

A number of diseases are now known to be caused by the filter-passing viruses. Infectious fluids from patients suffering from these diseases, in which no visible germ has been found to be present, have been filtered,

and the products have brought about the disease in a succession of experimental animals. Quite recently it has been shown that influenza is due to infection with a filter-passing virus. Other diseases so caused are infantile paralysis, mumps, distemper, sleepy sickness, measles, chickenpox, and smallpox. There is every reason for believing that these filter-passing viruses are living organisms, but whether they are just very small bacteria or a different order of living things is not yet known.

One very remarkable discovery has been made in connection with ultra-minute organisms. An Englishman, Twort, and a Frenchman, D'Herelle, have found that cultures of bacteria on artificial media can be killed by some 'thing' which passed through filters, and that this destructive 'thing' can be transmitted from one culture to another. D'Herelle has come to the conclusion that the 'thing' is a filter-passing virus which preys upon bacteria, and calls it bacteriophage (germ-eater).

So in the filter-passing viruses and the bacteriophage scientists appear to have discovered a new kind of living organism, an animal or vegetable, whichever it may be, which is so minute that it cannot be seen by ordinary microscopic means.

Disease Germs

In the last few pages some general idea has been given of the rich and varied life of minute organisms that exist on the borderland between the animal and vegetable worlds, and some of the steps that have been made in the discovery of this life have been traced. But our concern here is more especially with disease, with germs which have found the human body a suitable habitation with a plentiful and abundant food supply—although, if they run their course unchecked, they end by destroying the host that gives them shelter. Perhaps one of the most remarkable features about germ diseases is that they remain more or less true to type, one particular germ causing one particular disease. The typhoid bacillus has a special liking for the intestines, where it gives rise to ulcers. The diphtheria bacillus has a predilection for the throat; the meningococcus for the coverings of the brain. When a germ attacks the body and produces disease the symptoms complained of by the patient and the signs found by the doctor are, in the main, characteristic; and, taken together, they enable the doctor to diagnose with more or less certainty the kind of disease affecting the patient, and the germ which is causing it.

Take the case of pneumonia. The patient suddenly falls ill with a shivering attack and a pain in the chest. He has a cough and breathes rapidly. The symptoms indicate to the doctor that something is wrong with the lungs. Examination of the lungs reveals signs which the

experience that has been handed down from one generation of doctors to another shows to be associated with an acute inflammation of the lungs—a condition to which the name of pneumonia has been given. The researches that have been carried out during the past fifty odd years have proved that this inflammation is most commonly caused by a germ having special characteristics and a life-history of its own, a germ which we call the pneumococcus. This knowledge is of the greatest importance to the doctor, for it makes it possible for him not only to treat the patient, but to take special measures directed against the germ itself by injecting a serum that is specifically 'anti-pneumococcus.'

WHERE DO DISEASE GERMS COME FROM?

The bacteria that cause typhoid and cholera can exist and flourish outside the body, in damp soil, and in water. If they are swallowed in infected drinking water they may give rise to disease. It would appear, however, that other microbes, such as those which, for example, are responsible for venereal disease and tuberculosis, cannot live outside the body; nor are the filter-passing viruses found free in nature. They are obliged to live a parasitic existence. Many microbes find shelter on the surface of the body and within its passages, on the skin, in the mouth, and in the intestines, without doing any harm. They may continue to cohabit peacefully without making their presence felt. Changes may, however, take place in their constitution or in that of the body, causing these formerly inoffensive germs to attack their host. When the general health is below par, boils, styes in the eye, or carbuncles may result from infection with a microbe called the staphylococcus, which is always present on the skin. Dangerous germs like the pneumococcus may inhabit the throat for a long time without doing any harm, but may suddenly become disease-producing for the person in whose throat they live, and for others with whom this person may come into contact. More strangely, some people may carry the germs of disease and infect others without themselves suffering any ill. These 'carriers,' as they are called, may have suffered from a disease and have recovered from it, but may not have got rid of the germ which caused the disease. This happens, for example, sometimes in diphtheria, and in typhoid, when the bacillus is still found long after the disease has disappeared. The danger is, of course, that the carrier, though being a healthy person in fact and in appearance, is yet a source of infection to all with whom he or she comes into contact.

THE SPREAD OF INFECTION.

Germs have many ways of carrying on their species. Infection can be conveyed by water, as in typhoid; by milk, as in bovine tuberculosis;

by air, as in smallpox; by droplets, as when a person with a cold or diphtheria sneezes; by clothes, as in scarlet fever; by lice, as in typhus; by mosquitoes, as in yellow fever; by fleas and rats, as in plague; by direct contact, as in venereal disease. Enough examples have been given to show that germs have explored, as parliamentarians say, every possible avenue that may lead them to a human being on whom they can feed and multiply, and then to spread to still more people. It seems surprising that once an infection has started it does not go on for ever, affecting the whole population of a country. One would think that once a germ had got going the only thing that would stop it would be geographical boundaries.

An outbreak of infectious disease in a community is called an epidemic, and, as there are many ways in which the illness may be spread, so there are several factors which help to keep it within bounds. The problem is a complicated one. Climate, overcrowding, the vitality of the population, the degree of infectivity of the germ, the isolation of infected patients, the tracking down and elimination of an infected food or water supply, preventive inoculation—all these help to modify, in one way or another, the extent of an epidemic. Another interesting feature of infectious diseases is that they change in character; scarlet fever and smallpox, for example, being much less grave diseases than they were thirty or forty years ago. Then there is the mystery of the sudden appearance of new diseases. Syphilis, for example, has no history before the fifteenth century, since when it has spread its ravages to all parts of the world. During the last fifteen years the disease known as sleepy sickness has come on the scene, with its appalling effects on the nervous system. From time to time an infectious illness seems to get the whole world in its grip—a pandemic as it is then called—as happened in the influenza terror of 1918–19, when as many as six million people died in India alone.

THE EFFECTS OF BACTERIA.

When an individual becomes infected by a germ, the latter has various ways of getting a foothold in the body. It may, as in diphtheria, lodge on the tonsils; it may reach the intestines, as in typhoid, or the lungs as in pneumonia; it may enter the skin through a cut, or through the bite of an insect as in yellow fever. While a germ may remain localized, it may instead break through local barriers and enter the blood-stream, there to multiply and carry disease to all parts of the body—a grave condition known as septicaemia. If we cut ourself with a dirty knife the wound may become septic, which means that germs have infected it. If the germs escape from the wound into the blood and there multiply, you have 'septic-aemia.'

The effects of bacteria on the health depend upon the nature of the

infecting agent and the constitution of the infected person. As to the first, the virulence of the germ, the numbers of it that are introduced into the body, and the path of entry it takes are determining factors. As far as the infected person is concerned a number of things must be taken into consideration. The physical and mental well-being, the age, and the social circumstances, of a man or woman will make a difference to the way in which he or she reacts to an illness. Some races are more susceptible than others to certain types of infection. Consumption in negroes is a more serious disease than is consumption in Europeans, while the Irish are more susceptible to this complaint than are the English. Patients suffering from diabetes are very often afflicted with boils and carbuncles, and are abnormally susceptible to tuberculosis.

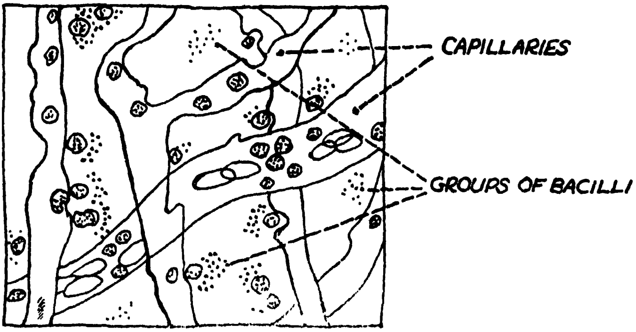
HOW DISEASE GERMS ACT.

Once disease germs have entered the body they multiply very rapidly, and their growth is accompanied by the formation of chemical products which act as poisons to their host. The germs that cause tetanus (lock-jaw) and diphtheria manufacture large quantities of poison which we call toxins, and the serious symptoms of these two diseases are due to these toxins and not directly to the germs themselves. The diphtheria bacillus grows on the tonsils and remains there, but the toxins it produces spread through the body and give rise to the symptoms characteristic of diphtheria: these toxins may paralyse the nerves or bring about heart failure. Other germs do not pour out toxins in such abundance. Their poisonous activity is mainly confined to the particular place in which they happen to lodge and multiply, and many of their manifestations depend upon the particular part of the body attacked. In typhoid fever, for example, the abdominal pain and diarrhoea are due to the formation of ulcers in the intestine.

The chemical poisons that result from bacterial activity manifest themselves in the fever, headache, quickened pulse, feeling of illness, etc., which are characteristic symptoms of most infections. If the bacteria settle chiefly in the brain, then such symptoms as convulsions and loss of consciousness occur; if they settle mainly in the lungs, then the patient will cough and spit and, perhaps, breathe with difficulty. All infections, then, are characterized by certain general effects due to the general action of chemical products resulting from the growth and multiplication of bacteria in the body, and by certain special effects. These latter, as we have seen, depend upon the part of the body attacked, and also upon the fact that certain poisons have special affinities with particular tissues of the body. For example, the toxins of the diphtheria bacillus, manufactured in the throat, have a predilection for nerves, and so often cause paralysis—a paralysis which is fortunately not permanent.

THE REACTION OF THE BODY.

Other sections of this book have dealt with inflammation and the process of immunity, so brief mention only will be made here of these ways in which the body meets invasion by bacteria. The curious thing about the inflammation resulting from such invasion is that bacteria in some way attract those cells of the body which will at once attempt to destroy them. In suppuration, for example, there is an increased production of the small white cells of the blood called the polymorphonuclears; elsewhere, germ-infection calls out the large cells formed in the lymph glands, the spleen, the bone-marrow, and the



EMIGRATION OF PHAGOCYTES

liver. When these cells, large and small, arrive at the site of infection a fight goes on between them and the germs, with heavy casualties on both sides. This fight may be sudden and severe, as in acute inflammation; or it may drag on with rather indefinite results, as in chronic inflammation. The germs attack the cells with their poisons, and the cells engulf the germs—phagocytosis, as the process is called. Inflammation is thus one of the mechanisms of the body for defending itself against invasion by bacteria.

Immunity, as is explained in the section dealing with this subject, is a complicated affair. The immune bodies that are produced in response to infection by germs combine with the bacteria and their toxins, neutralizing them, and preventing them from attacking the cells of the body. Some people have a natural immunity to certain diseases, and go through life without ever catching, say, measles. Other people may acquire immunity by passing successfully through an attack of a disease. With measles a second attack is extremely rare; immunity to it is lasting. In other illnesses, of which influenza is a notorious example, immunity is short-lived, and one may suffer from several attacks within a short time. This property possessed by us of

producing immune bodies forms the basis of the modern treatment by vaccines and serums.

When microbes assault the body and succeed in producing disease the body responds with fever; and by fever is meant a change in metabolism, and a temperature raised above the normal. Whether or not this response of fever is beneficial is disputed, but the reduction of temperature (when not extraordinarily high) by means of drugs does not appear to be very helpful, and is nowadays discouraged by doctors. On the other hand, extreme temperatures of over 103° F. (the normal is 98·4° F.) seem to be detrimental, and attempts are usually made to lower them by sponging the body and by reducing the bed-clothes to a minimum. The metabolic changes that occur in fever certainly do not appear to be of any obvious good to the body. There is a conspicuous wastage of body-tissue, the destruction of proteins being particularly marked. There is interference with the assimilation of food-stuffs from the intestine, and diminished activity of the kidneys. The frequency of the heart-beat and of the breathing is increased. Although the skin is hot and flushed there is typically a lessened secretion of sweat. There may be an increased loss of water by way of the breath, but not enough to compensate for the increased production of heat.

Many fevers start with a severe shivering attack, in which the skin feels cold and looks like 'goose-flesh,' a phenomenon due to the contraction of the blood-vessels, and of the smooth muscle under the skin. This contraction prevents loss of heat, whilst the action of the muscles in shivering leads to heat production. The shivering attack, or rigor, is a method the body has, so to speak, of getting up steam. When the disease has run its course, the temperature falls; either gradually, by 'lysis,' or suddenly, by 'crisis': this latter occurring typically in pneumonia. The sudden fall of temperature in crisis is accompanied by profuse sweating. Once a man was born who was normal in all respects but one; he had no sweat glands and so could not perspire. He could not work in the summer because the muscular exertion sent up his temperature too high; the only way he could keep going was to soak his shirt in water. This is an actual fact, and shows how the interaction of muscular exertion and sweating helps in the regulation of body temperature.

Methods of Dealing with Germs

In 1867 the English surgeon, Joseph Lister, published a paper entitled *On the Antiseptic Principle in the Practice of Surgery*. For a long time Lister, with most of his contemporaries, had been gravely perturbed by the 'septic' complications of operations. Although a most careful

operator, 42% of his amputation cases were fatal. By chance he became acquainted with the work that Pasteur was doing in France, and he set about trying to prevent the development of germs in wounds. Lister realized that Pasteur's method of heat sterilization could not be applied to wounds, so he searched for a chemical antiseptic. He experimented with zinc chloride and with the sulphites, and finally hit upon carbolic acid, which he painted, at first, directly on the wound. Later he sprayed his operating theatres with carbolic acid, and also incorporated it in the dressings he put on wounds. Lister's antiseptic surgery prepared the way for the modern aseptic surgery, in which the surgeons and nurses wear sterilized gowns, masks, and gloves; the patient is covered with a sterilized sheet with an opening over the place on which the surgeon is to operate; the knives, forceps, and towels are sterilized, and the patient's skin is painted with an antiseptic such as iodine. In this way all the germs are killed before the operation begins. Lister was indeed the founder of modern surgery.

Since the early work of Pasteur, Lister, and Koch (who proved the value of mercuric chloride for destroying the spores of bacteria) the principle of disinfection—the killing of germs—has been thoroughly worked out. Germs can be killed by heat, by sunlight, by such chemicals as potassium permanganate, mercuric chloride, iodine, spirit, chlorine, phenol and cresol, and they can be excluded from water by filtration. By methods based on this knowledge our water supply has been made safe for drinking purposes, and the incidence of such diseases as cholera and typhoid enormously cut down. A question of disinfection that has long been before the public eye—and should weigh more heavily upon the public conscience than it appears to do—is that of safe milk. Approximately two thousand children die every year from infection by the bovine tubercle bacillus, and four thousand fresh cases are infected annually. Children are infected by this germ through contaminated milk. Pasteurization (that is, a special method of heating) of milk would greatly diminish this appalling death roll, yet the opposition of individual farmers is allowed to prevent the taking of a measure so essential for the public safety. In the meanwhile the wise mother will see that her child does not receive milk which has not been either pasteurized or boiled.

Germs not only infect milk and water, but they also contaminate food, and outbreaks of food-poisoning are frequently traced to contaminated food sold in a shop or a restaurant; as was the pease-pudding outbreak in the St. Pancras area of London in 1933, which was due to a particular germ. The large catering firms keep a very strict control over their food, and have it continually tested for the presence of germs, for the protection both of their customers and themselves.

In most districts it is now compulsory for such infectious diseases as

measles, scarlet fever, and diphtheria to be notified; patients suffering from these illnesses being usually treated in special fever hospitals, so that by the segregation of the infected the disease can be brought under control. Another way to limit these infections is by the inoculation or vaccination of the community against them. The most famous example of this limitation is smallpox, which is now, largely thanks to vaccination, an uncommon disease. The man who introduced vaccination against smallpox was a physician called Jenner, who was born in the eighteenth century. Jenner noticed that dairymaids who, through milking cows, contracted the mild malady called cowpox never succumbed to smallpox. From this fact he conceived the simple but brilliant idea of protecting people from the dreaded scourge of smallpox by giving them the milder and inoffensive disease of cowpox —and this is the method that has been practised ever since. Attempts have, of course, been made to protect populations against other infections, and remarkable success has been achieved in America in immunizing children against diphtheria by the injection of small quantities of diphtheria toxin and anti-toxin. The incidence of diphtheria and the mortality from it has been considerably reduced in the United States of America as a result of this practice.

Measures of protection against infection in any community are greatly helped by finding out which of its members are susceptible to a given disease. Three diseases with regard to which a test for susceptibility is frequently carried out are tuberculosis, scarlet fever, and diphtheria. If a very small quantity of the toxin from the diphtheria bacillus is injected under the skin of a person susceptible to diphtheria a raised red patch, less than an inch in diameter, will appear at the site of injection within one to two days. If the patient is immune —that is to say, if he already has anti-toxins to this disease in his blood —this red patch will not appear. The same kind of test is carried out with scarlet fever and with tuberculosis. This method of finding out which individuals are liable to catch diphtheria or scarlet fever is of particular value in schools and in fever hospitals, as the susceptible children and members of hospital staffs can be immunized against the infections in question. These two tests are called after the names of the scientists who instituted them—the Schick test and the Dick test, respectively.

Some of the most successful results in the prevention of disease by means of vaccines have been obtained in typhoid fever. As has been explained earlier the injection into a human being of killed bacteria induces in the blood the formation of anti-bodies to those same bacteria. Thus, when a person so vaccinated is exposed to actual infection with the live bacteria he will be already armed with anti-bodies to deal with them. It has been said that if it had not been for vaccination against

typhoid the last war would have come to an end very much sooner than it did. As it was, inoculation of the fighting forces against typhoid, on a vast scale, protected them from the attacks of this disease and preserved them for the far more horrible ravages of war. On a much lower plane we may note the brilliant results obtained in protecting dogs against distemper. Dogs can now be inoculated against this once devastating disease with nearly a 100% guarantee of success. The reader may get some idea of the arduous and prolonged character of scientific research when he is told that this work on dog-distemper took ten years to complete, and cost £50,000. Incidentally, the investigations led to the discovery of the cause of influenza. In time, we may hope, the cure of this international malady may also be discovered.

ACUTE INFECTIVE FEVERS

Up to this point we have been chiefly concerned with the general characteristics of bacteria—what they are, how they live, what effects follow upon their invasion of the body, how the body resists them, and what are the general methods that we employ when combating these microscopic but powerful organisms; sometimes enemies of society, sometimes bringers of good gifts. The next paragraphs will be devoted to a more detailed description of some of the commoner infections, and in this it is not intended to follow a strictly logical order according to the types of bacteria that cause these infections, but to group them in a way that can be easily followed by the reader. We begin with the common fevers—diphtheria, measles, scarlet fever, whooping-cough, mumps, and chickenpox.

These fevers are characterized by a sudden onset of illness, with raised temperature and certain symptoms and signs the grouping of which differentiates one fever from another. Each fever runs a typical course, which may or may not be interrupted or prolonged by complications peculiar to itself. Thus scarlet fever starts suddenly with headache, sore throat, and vomiting; a rash appears within the first twenty-four hours of the disease; the temperature is usually normal by the sixth day; whilst inflammation of the kidneys and of the ears is a common complication. These features distinguish scarlet fever from other infections, and enable physicians to identify and classify it as 'a disease' by itself. Later in the field come the bacteriologists, who find that this 'disease by itself,' or specific infection, is caused by a 'germ by itself,' or specific microbe. The diagnosis of a typical case of scarlet fever, for example, does not present any difficulty to the experienced doctor; but in mild cases and in cases which are first seen in a late stage of the disease diagnosis is often by no means easy. For

instance, a child with an ordinary sore throat may have a rash resembling very closely that of scarlet fever. Overdoses of certain drugs, mild food poisoning, or the giving of an enema may also set up a scarlet-fever-like rash, and a similar rash may appear in measles, smallpox, and chickenpox. So in examining a child with a rash like that found in scarlet fever the doctor has to bear in mind the various conditions that can be associated with such a rash. The character of the rash, the parts of the body covered by it, the presence of some signs and the absence of others, the story the patient tells, etc., all help him to make up his mind. But, even so, diagnosis is not always easy.

SCARLET FEVER.

We have already mentioned some of the characteristic features of scarlet fever. It is common in Europe, being especially prevalent in England in the autumn months. Mainly a disease of children, it can also attack adults. It is caused by infection with a small spherical germ, called the streptococcus of scarlet fever.

When a germ invades the body the patient does not necessarily become ill at once. There is a period called by doctors the incubation period which varies in duration with different fevers—between the actual infection with the germ and the first manifestations of illness. That is why children who have been exposed to infection are put into quarantine (that is, separated from others for a certain time). If the period of incubation is, say, three days, and a child is exposed to infection early on a Monday, it will not be known until late on the Wednesday whether he or she has caught the fever. A safe quarantine period for scarlet fever is usually considered to be ten days. The infective agent of scarlet fever is undoubtedly present in the secretions of the throat and the nose, and it is easy to see how infection can be spread by towels, handkerchiefs, feeding utensils, clothes, bedding, etc. The necessity for disinfecting such articles is obvious. Sometimes milk has become contaminated, and widespread epidemics have broken out as the result of such contamination.

The child with scarlet fever usually has brightly flushed cheeks with definite pallor round the mouth. The vivid scarlet rash appears first on the sides of the neck and the upper part of the chest, and then extends downwards over the whole of the body. It consists of minute, brilliantly red points set very close together. By the end of the first week the rash has usually faded, coincidently with a fall in temperature. Other distinctive symptoms have been mentioned above. With the fading of the rash the skin begins to peel, sometimes coming off in long flakes, sometimes as a light powder. This peeling continues from the end of the first week for another four or five weeks. It used to be thought that the peeled-off skin was infective, but this view is no longer

Photo by Herbert Williams

GYMNASTIC POSE—TRIPOD SUPPORT—ELBOWS AND HEAD

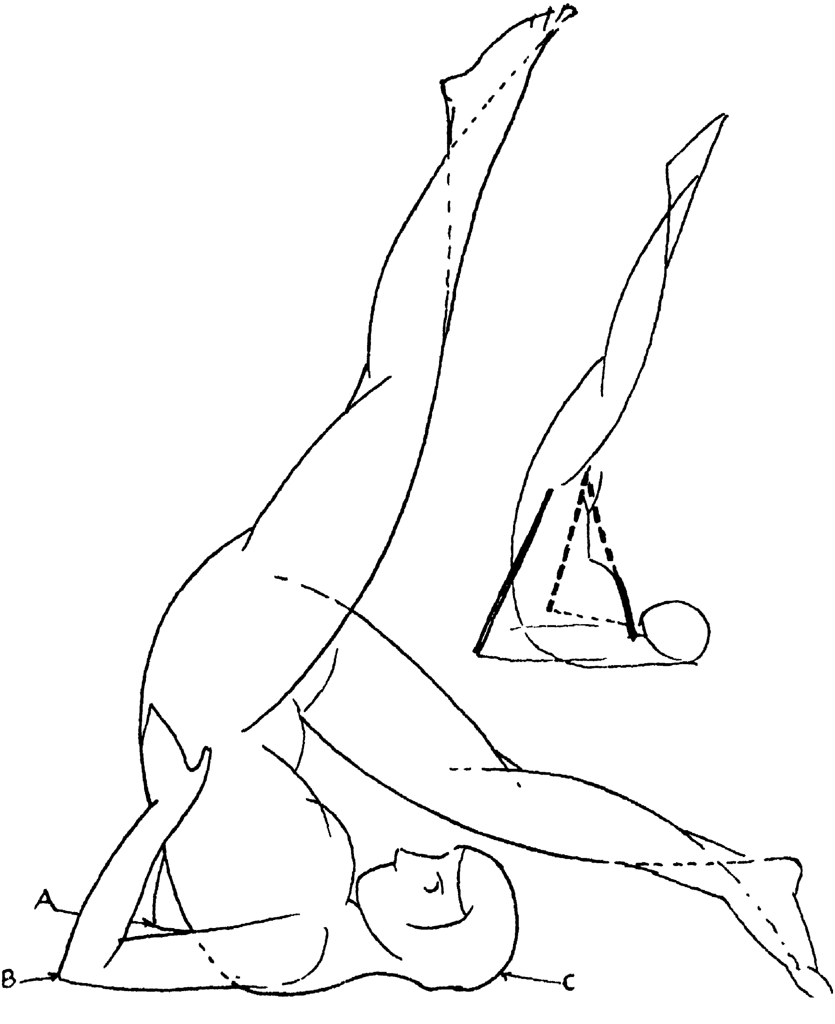


DIAGRAM OF SUPPORT

A, B, C, feet of supporting tripod

held, and children are often allowed to go home from hospital after four weeks have elapsed. If, however, a child has a 'running nose,' it is detained in hospital so long as the nose runs, for it is by such discharges that infection can still be spread, although the child may feel and appear quite 'well.'

Scarlet fever is, fortunately, not the serious disease it used to be; but such complications as infected glands in the neck, which may have to be lanced, inflammation of the ear, and of the kidneys, may occur and have to be specially treated. Bad cases of scarlet fever are often now injected with an anti-scarlatinal serum, which is undoubtedly beneficial. The essential treatment is the keeping of the patient in bed while isolating him from other children. As three weeks is the average period for this, it can be done most conveniently and efficiently in a special fever hospital. Care must be taken during convalescence from scarlet fever as at this stage patients are especially liable to contract diphtheria. There is now a special test (the Dick test) for finding out what children are susceptible to scarlet fever, and those who are susceptible can be inoculated against the disease.

MEASLES.

There seems little doubt that measles is caused by a specific microbe, but as yet this microbe has not been identified. Measles is a serious disease, being especially common during the first five years of life and in the winter months. A second attack in the same individual is exceedingly rare, so that a high degree of immunity must result from the illness. It is a highly infective malady and is usually transmitted directly from person to person, by the infective material present in the discharge from the nose and throat. One sneeze may do a lot to spread an epidemic. The incubation period is about a fortnight, and the quarantine period fifteen days. The most infectious period is in the early stages of the disease, during which the diagnosis may, unfortunately, still be in doubt, as the rash typical of measles does not appear until the foruth day of the disease. There, are of course, certain signs which may help the doctor to make an early diagnosis—such as the little white points that can be seen in the inside of the mouth—but it is not infrequently a matter of some difficulty.

Measles starts with an acute catarrh of the eyes, nose, and throat; bronchitis, and a fairly high temperature. The child usually feels ill and miserable, and does all it can to shield its eyes from the light: it 'runs' at the eyes and the nose. In a measles epidemic any child that seems to have a severe cold in the head should be seen by the doctor. The rash, which appears on the fourth day of the illness below the ears and about the roots of the hair on the brow, afterwards spreading over the face and then over the rest of the body, consists of raised spots

ranging in colour from dusky red to pink. These spots are grouped together in clumps, giving the skin a blotchy appearance. After about two days the rash begins to fade. Within a week, unless there are complications, the temperature is normal.

It is the likelihood of certain complications that makes measles a grave disease, and of these the most serious is broncho-pneumonia, which not only is difficult to treat, but sometimes permanently damages the lung. Laryngitis, inflammation of the ear, and various nervous troubles may also follow. A child with measles is best treated in a fever hospital, where he will get skilled nursing and constant medical attention. Measles is now often successfully treated with serum obtained from patients who have had and recovered from the illness. This serum can be given to the healthy as a preventive measure in an epidemic, or to the infected in the early stages of the disease. The amount of serum available in a normal community is, of course, limited, but its employment is certainly of great use.

GERMAN MEASLES.

German measles and measles are distinct diseases. 'German' is not a continental variety of 'English' measles. It is a mild malady, common in the spring and early summer. The germ that causes it has not been discovered, but the infective agent is apparently present in the catarrhal discharges of the nose and the throat. The incubation period is long —somewhere between a fortnight and three weeks—and children who have come into contact with the fever should be in quarantine for the longer period. Patients in whom the disease has appeared should be isolated for ten days. German measles starts with a cold in the head, with running at the eyes and the nose, and a rise of temperature. In a typical case there is definite enlargement of the glands in the neck. The rash of rose-pink separate spots may be the first thing to be noticed, and does not usually appear later than the second day of the disease. It appears first on the brow and behind the ears, and then spreads over the body.

Severe complications are very rare, as are second attacks. The temperature is normal within a week, and during this time the patient should be kept in bed on a light diet. Otherwise no special treatment is needed.

SMALLPOX.

It is an interesting and curious comment on our boasted civilization that, with the means of absolutely preventing smallpox at our disposal, we allow the prejudices of a small minority still to expose the country to not infrequent outbreaks of a peculiarly repulsive and filthy disease. But unfortunately, so long as vaccination and revaccination cannot be universally

enforced, smallpox will continue to be with us and, unfortunately also, will continue to be the cause of most regrettable loss of life and waste of money.

The above is a quotation from a well-known textbook on infectious diseases. It seems that at present the number of unvaccinated people in England is increasing yearly. To-day the type of smallpox prevalent is mild: if a severe form of the disease broke out the consequences would fall most heavily on the unvaccinated. Since the introduction of vaccination there has been a marked fall in the incidence of and mortality from smallpox; and most doctors—though not all—believe that the disease could be stamped out completely if the whole population was vaccinated. General medical opinion is that infants should be vaccinated in the first six months of life; and that revaccination should be carried out at the ages of five to seven years when the child goes to school, and again when he leaves school, between fourteen and sixteen. If infants are vaccinated during the first three months of life and with the methods at present in use, the rare nervous complications that have been reported do not now occur.

The germ which causes smallpox has not yet been discovered, but it is probable that it is a filter-passing virus. The incubation period is from ten to fourteen days, and the quarantine period sixteen days. A patient with the disease is usually isolated in a special hospital for from six to ten weeks. Smallpox attacks people of all ages, and is a disease chiefly of winter and spring. It spreads by direct infection from person to person; possibly, also, by the air. Clothes and bedding are infectious and need disinfection, as does the house in which the patient has lived.

The disease starts suddenly with headache and shivering as prominent symptoms, and a high temperature. The rash appears on the third day of the illness. To begin with it consists of dull red spots, which soon become raised above the skin, on the brow, and on the wrists. Later these raised spots become filled with a clear fluid, which by the eighth day turns into pus or 'matter.' Later these 'pocks' burst, a scab forms and separates, and a scar is often left behind. The temperature is normal by about the sixteenth day. Laryngitis, bronchitis, pneumonia, and ear disease are among the complications of smallpox. In an epidemic it is most important to call in a doctor, even if the suspect has only three or four raised spots on the skin and does not appear to feel ill.

CHICKENPOX.

Chickenpox in many respects resembles smallpox, and is usually only distinguishable from it by a doctor; though it has no apparent connection with the latter disease. It is probably caused by a filter-

passing virus. Relatively a mild disease, it is most prevalent during the autumn months, and commonly attacks children during the first ten years of life. It spreads by direct contact from case to case; possibly, also, infection can be conveyed by air. The incubation period is from two to three weeks, and the quarantine period is three weeks.

The rash is usually the first symptom to be noticed. This appears as a raised spot which soon forms a circular or oval blister or vesicle containing clear fluid, which fluid later becomes cloudy or purulent, that is, containing pus. The spots are found on the chest and the back, the face, and the scalp, in the mouth, and to a less extent on the limbs. The fluid in the spots either dries up or escapes on to the skin. A scab forms and finally separates. The rash is often very irritating, and the patient has to be discouraged from scratching, otherwise scarring may result. The fever is not usually high, and subsides within a week.

There seems to be a close connection between chickenpox and shingles. Children with chickenpox should be quickly isolated from others, and kept in bed until the temperature is normal, and away from other children until all scabs have separated. Second attacks are extremely rare.

MUMPS.

The infectious diseases we have so far discussed are characterized by rashes of various kinds. Mumps, which is a disease caused by a filter-passing virus, is an infection of the gland called the parotid, situated behind the angle of the jaw. It is one of the glands which secrete saliva. Mumps is a disease of the spring and the autumn, and is common among children between five and fifteen years of age; though adults are occasionally attacked. The incubation period is from twelve to twenty-six days, and the quarantine period is twenty-six days. Infected children are usually isolated for three weeks.

It often starts with headache, chilliness, and nose-bleeding, and the first noticeable symptom is a swelling on one side of the neck between the angle of the jaw and the ear; the gland on the other side usually swells a day or two later. The swelling is very tender, and eating and laughing and even opening the mouth become painful matters. The appearance of the patient is slightly grotesque and rarely evokes sympathy. Within a week to ten days the swelling subsides, but the patient should be kept in bed for the full ten days. As the virus is short-lived, disinfection of clothes and so on is not really necessary. Second attacks are very rare.

It is important for the patient to be kept in bed in order to avoid the risk of complications. Ear disease and deafness, inflammation of the pancreas, and swelling of the testicles are not common, but when they occur are serious sequels to mumps.

WHOOPING-COUGH.

This troublesome complaint is common amongst infants and young children between January and April. It is caused by a bacillus and is highly infectious, spreading directly from patient to patient and by the clothes. The incubation period is from a few days to a fortnight, and the quarantine period is twenty-one days.

Whooping-cough starts as a bad cold, the patient sneezing and running at the eyes, becoming listless, and going off his food. Soon the cough comes on in spasms and the child is often sick; and, finally, the typical whoop appears. The patient has a succession of coughs as if he were trying to get rid of something; during this coughing bout he does not breathe in, and the bout is ended by a long drawing in of air which produces the crowing noise we call a whoop. After the whoop the child is often sick. During the paroxysm the face and the eyes are congested and swollen; there may even be a haemorrhage into the eyelids and the whites of the eyes. These paroxysms are very exhausting, and the unfortunate invalid, with his pale, puffy, weary-looking face, is a picture of misery.

Amongst other complications bronchitis, pneumonia, and convulsions are the most serious. The average period of isolation is six weeks.

Whooping-cough is a serious disease and must be kept under careful medical supervision. Children in a poor state of health may later on develop tuberculosis unless every effort is made to build up their health during their convalescence. Some success has been obtained in vaccinating against whooping-cough, but this is not practised on a large scale in England.

DIPHTHERIA.

The treatment of this illness has largely fulfilled the expectations of the discoverers of the disease-producing germs. Taken in its early stages it responds dramatically to injections of anti-toxic serum, and preventive inoculation is remarkably successful in protecting children against infection. A special skin test (the Schick test) enables the doctor to find out what children are susceptible to the disease. In America the incidence of diphtheria has been considerably reduced as the result of a widespread and thorough-going compaign of inoculation. In England we still lag far behind in this respect, but there seems little doubt that if the pre-school and school-age population could be vaccinated against diphtheria it would become a rare disease, and an avoidable mortality would disappear.

Diphtheria is common among children between one and ten years old in the winter months. It spreads by direct contact—for example, by kissing—by infected pens and pencils in schools, by infected clothes

and towels, and sometimes by milk. We have previously mentioned the spreading of this disease by healthy carriers. The domestic cat has also been blamed, but, it is thought, unjustly. The bacillus that causes diphtheria may attack the throat, the nose, or the larynx. The incubation period is from one to three days, and the quarantine period twelve days. The quarantine period is not here relevant, for the doctor usually makes a bacteriological examination of the throats of suspects or contact cases, as discovery of the bacillus under the microscope is the surest way of diagnosing the disease.

At the onset of the illness the child feels ill, with perhaps a headache and vague pains. The throat feels sore and there is fever. A white patch appears on one or both tonsils and soon spreads. At the first sign of a sore throat in a child the parent should immediately send for a doctor, for any sore throat may turn out to be diphtheritic, or, on the other hand, may be the beginning of scarlet fever. The important thing to remember is that the sooner the child with diphtheria can be given anti-diphtheria serum the better will be its chances of recovery. The whole idea of the treatment is to stop the disease before the toxins of the diphtheria bacillus can establish themselves in the tissues of the body and do serious damage. In a suspected case a doctor will usually inject serum or send the child into a fever hospital before it has actually been proved that the patient is suffering from the disease. This is a wise measure and should not be resisted by those responsible for the child. As a result of serum treatment the case death rate from diphtheria has decreased considerably; but diphtheria remains still a prevalent and serious illness. Patients who have had serum injected frequently develop a rash and complain of pains in the joints (serum sickness), but this is no cause for alarm. Very occasionally, severe shock immediately follows the injection of serum, but this can nearly always be controlled by the injection of a drug called adrenalin.

Second attacks of diphtheria are not uncommon, and the doctor should always be informed if a child has ever had a previous injection of serum. It is a curious but explicable physiological fact that the shock just mentioned usually occurs when second injections of serum are given after a certain interval of time has elapsed.

The toxins produced by the bacillus affect the kidneys; and may attack the nerves and cause paralysis of the eyes, of the palate, and of other parts of the body: whilst they may also bring about a serious failure of the heart and circulatory system.

A very grave complication occurs when diphtheria spreads to the larynx and the child develops a croupy cough. The larynx may become blocked up and the child be unable to breathe. In this serious emergency the doctor may have to perform an immediate operation by making a hole in the windpipe just below the larynx (the Adam's

apple), and inserting into the hole thus made a metal tube through which the patient can, temporarily, breathe.

ENTERIC FEVER.

Enteric fever is a name given for convenience to a group of allied diseases caused by similar organisms, the typhoid, and the three paratyphoid, bacilli known as A, B, and C. Of these, typhoid fever is the most serious and will here be the only one considered; for much of what is said about typhoid applies also to the paratyphoid fevers. Typhoid occurs in all parts of the world, is most prevalent in autumn, and is commonest between the ages of ten and twenty-five. The infection is conveyed by water and milk, by food (e.g. watercress, ice cream, and shell-fish), by contaminated bed-linen, and by 'carriers.'

The typhoid bacillus attacks the small intestine, and the bacilli pass out in the faeces of the patient. Therefore, if the drainage is defective, neighbouring water supplies may easily become contaminated, as in a well-known outbreak at Malton in Yorkshire. The organism is killed if submitted to the temperature of boiling water for three minutes. Owing to our vastly improved methods of sanitation, typhoid is now an uncommon disease in England. When, as in the army in war-time, people are crowded together and the sanitation is bad, protection can be secured by inoculation against the typhoid and paratyphoid fevers. The disease can be diagnosed at the end of the first week by a special laboratory test—the Widal test. The incubation period is between one and three weeks.

Typhoid fever starts with a general feeling of illness, headache, pains in the back and limbs, insomnia, loss of appetite, bronchitis, pain in the abdomen, occasional vomiting, and either constipation or diarrhoea. There is also a heightened temperature, which gradually rises during the first week. During this period diagnosis is often difficult, as there is nothing pointing very clearly to any specific infection. Towards the end of the first week the spleen may be felt to be enlarged, rose-pink spots appear on the abdomen, the bacillus can be found in the faeces, and the Widal test is 'positive.' The fever may continue for another two weeks, and even longer. Relapses are common. During the second and third week the patient, in bad cases, often becomes deaf, delirious, stupid, and extremely weak. He also suffers from a troublesome diarrhoea. At this time haemorrhage or perforation of the bowel may occur, since ulcers form in the intestine as a result of the infection. Pneumonia and clotting of blood in one of the veins in the groin are other common complications.

A patient with typhoid is best treated in a special fever hospital. It is a serious disease, and calls for the greatest skill in nursing: many a typhoid patient owes his life to the attention of an experienced nurse.

TYPHUS FEVER.

Typhus or jail fever is now practically unknown in England, but is prevalent in Russia and the Balkans. It is a louse-borne disease, and disappears with the spread of public hygiene and personal cleanliness. It was once very prevalent, and in jails notoriously endemic; on one occasion, still remembered as the 'Black Assizes,' infection from the prisoners on trial carried off judges, counsel, and court officers.

CEREBRO-SPINAL FEVER.

This is also known as spotted fever. It is an inflammation of the covering skins or membranes (meninges) of the brain and spinal cord due to invasion by a germ called the meningo-coccus. It is not uncommon in children under fifteen, and is especially frequent in infants. From time to time there are outbreaks of the disease in the army as conditions of close personal contact and overcrowding favour the spread of the disease. The germ lurks in the throat, and is conveyed from one person to another by coughing, sneezing, or kissing, or drinking from infected vessels. Healthy people may carry the germ in their throats and infect others. The incubation period is probably from one to five days.

Attacking as it does such an important structure as the covering of the brain and the spinal cord, cerebro-spinal fever is a grave disease. It starts very suddenly with a severe headache, vomiting, and stiffness of the neck. Shivering attacks, or in children convulsions, are also common. The temperature rises, and the patient become delirious and often violent. Small haemorrhages appear under the skin, whence the name spotted fever. If recovery takes place the unfortunate patient may be permanently disabled with paralysis, deafness, or other disabilities, some of them psychic.

The outlook in this disease has considerably improved since the introduction of two important measures of treatment. As we know, the brain and the spinal cord are surrounded and protected by a bag of fluid called the cerebro-spinal fluid. This fluid can be tapped if the tip of a hollow needle is pushed into the sac containing it, and two convenient places for this operation are just below the base of the skull at the back of the neck and at the lower end of the spinal column. The needle is inserted between adjacent vertebrae. In spotted fever the cerebro-spinal fluid becomes very thick, as a result of the infection; more fluid than normal is also secreted, and this gives rise to an increase of pressure on the brain and spinal cord. If the doctor drains off this excess fluid he relieves the pressure, and also removes some of the infected matter. The other measure is the injection of an anti-meningococcus serum into the cerebro-spinal fluid and into the blood-stream,

either under the skin, or into the muscles of the patient. These two methods of treatment have together much reduced the mortality of spotted fever.

ERYSIPELAS.

Erysipelas is an inflammation of the skin caused by a germ called the streptococcus. There are many varieties of streptococcus; erysipelas is probably due to infection with one particular variety. It is common in the winter months in persons between the ages of twenty and sixty, and spreads by direct contact and by infected clothes. The incubation period is three to eight days.

Erysipelas starts suddenly with a shivering attack, and a rapid rise of temperature. The patient complains of headache and is sick. The characteristic inflammation often begins at the inner angle of the eye or in the neighbourhood of a nostril. A patch of redness appears and spreads over the face; the affected skin being deep red, swollen, tense, shiny, hot, and raised above the surface of the surrounding parts. As the raised, spreading edge advances the older inner part begins to fade in intensity. The redness is fairly vivid for from four to five days. The patient feels a burning, smarting sensation; the eyelids become extremely swollen; sleeplessness and delirium are common. Erysipelas may wander about all over the body. Relapses and second attacks are not uncommon, and possible complications include pneumonia and nephritis.

The most successful form of treatment is the injection of an anti-erysipelas serum. A thousand-and-one local remedies have been tried, but none is really successful.

Some Other Infections

VENEREAL DISEASES.

In his book, *Devils, Drugs, and Doctors*, Dr. Howard writes: 'The venereal diseases are involved in that great sex problem about which the ideals and ethics of Christian civilization centre. . . . A true perspective on sexual matters is lost because the facts are obscured with secrecy and distorted in the imagination.' Gonorrhoea and syphilis are the two venereal diseases which have caused an appalling waste of human happiness, health, and money. These infections attack the genital organs of men and women. The infection spreads from one person to another as a direct result of sexual intercourse with an infected person. In very rare cases infection may be conveyed by contaminated towels or clothes, or from lavatory seats. Man and wife, neither of whom have or have had sexual relations outside marriage, do not

contract the disease, which depends for its continuance upon promiscuous sexual relationships.

Gonorrhoea is the result of an infection with a germ called the gonococcus. It is an acute inflammation of the sexual organs of the male and the female, and is characterized by a discharge from these organs. It is extremely difficult to treat successfully unless taken in the early stages, and any one infected or who suspects an infection should immediately seek advice from his or her doctor or, if certain of the nature of the trouble, at the nearest venereal disease clinic. The complications of gonorrhoea are troublesome and serious, and may result in years of misery and grave ill-health. It is perhaps unnecessary to say that any one with gonorrhoea should not have sexual intercourse until he or she has been properly treated, nor should any one who has had it marry until he or she has been carefully tested by an experienced doctor to make sure that the risk of infecting another person no longer exists.

Syphilis is due to infection with a thin, spiral-shaped microbe called a spirochaete. The disease first shows itself as a round, hard sore, about the size of a threepenny bit, on the external genital organs of the male or the female. About three or four weeks after the sore has developed, a rash appears on the body and simultaneously with, or following, this certain other symptoms such as a sore throat with ulcers in the mouth, and painful joints, may develop. Later on syphilis may—and, if untreated, certainly will—attack various parts of the body—the bones, the liver, the lungs, and so on. When it attacks the heart, which may occur some two to five years after the initial infection, the condition is very serious. But the gravest complications arise when the brain or spinal cord become infected, and this may happen as long as twenty years after the date of the original attack of the disease. General paralysis of the insane and locomotor ataxy are two of the most tragic results of syphilitic infection of the nervous system. It is largely on account of its after-effects that syphilis is of such grave consequence, no part of the body being immune against it. It is because of this, and of the tragic possibilities for others, that it is so essential for any one infected with syphilis to seek a doctor's advice at the earliest possible moment, and to submit patiently to the necessary course of treatment, however long it may be. Syphilis is one of the heritable taints; whilst if a woman has syphilis and becomes pregnant, her child, if born alive, will also be directly infected.

TETANUS AND ANTHRAX.

Tetanus, or lockjaw, is a disease caused by a long, rod-shaped bacillus. The tetanus bacillus is found in the soil in highly-manured fields and gardens, and in the faeces of various animals. Like diphtheria, it

produces its ill-effects by means of the toxins it excretes; and, like diphtheria, tetanus is now treated by an anti-toxic serum, though the results are not so universally good. The germ usually gains entry to the body through some cut or injury, and the disease begins as a slight stiffness of the jaw muscles, developing into a spasm which prevents the patient from opening his mouth. The spasm spreads to the muscles of the face, of the trunk, and of the limbs. Sudden intensification of the spasm takes place from time to time, causing the patient excruciating pain.

This grave disease is fortunately not common, though its mortality is high. Treatment with serum at the earliest possible opportunity gives the doctor his best chance of saving his patient. As a preventive measure, injections of anti-toxic serum are given to patients with wounds contaminated with road sweepings or garden soil. This treatment was used extensively in the Great War, in which soil-infected wounds were very common, and saved countless lives. Any serious wounds which are contaminated with garden soil or refuse should immediately be shown to a doctor, who may think it wise to inject anti-tetanus serum —tetanus being always a possible result of such wounds.

Anthrax, also known as woolsorter's disease, is a disease primarily found in sheep and cattle, and conveyed to man by the handling of hides, wool, and carcasses of infected animals. The germ which causes anthrax is a long rod-shaped bacillus. Anthrax begins suddenly and violently, the patient being almost at once acutely ill. The outward sign of the disease is a large spot, which looks very like a boil, on the face or the arms, or at the back between the shoulders. The bacillus may invade the lungs as a result of inhaling dust from infected hair or wool.

The disease is grave, but fortunately uncommon, and is now treated by anti-anthrax serum.

SLEEPY SICKNESS AND INFANTILE PARALYSIS.

Infantile paralysis is an acute disease of the nervous system caused by a filter-passing virus. This virus attacks those nerve-cells in the brain and the spinal cord which control muscular movement; and the characteristic feature of the disease is a wasting and paralysis of the muscles. It is a not uncommon malady during childhood and early adult life.

It begins as an acute illness, with fever, headache, and pains in the limbs, and soon paralysis of an arm or leg manifests itself. After the subsidence of the acute symptoms, some degree of paralysis always remains, but massage and exercises during convalescence do much to remedy matters; sometimes slight surgical operations are helpful. Where growth is completed at the time of the attack, the paralysis is

often the only sequel; but in children the wasting of the affected limb or limbs disturbs the muscular balance, and deformities and distortions of all kinds may develop as the child grows. Recently, attempts have been made to treat the disease with serum, but the evidence as to its value is conflicting.

Sleepy sickness also is an acute disease of the nervous system, and it too is caused by a filter-passing virus. This disease is now comparatively rare. Attacking the base of the brain, its gravest feature is its serious after-effects. After the patient has apparently recovered, he sometimes develops a slow form of paralysis, or manifests mental and moral changes that may necessitate permanent segregation from the community.

INFLUENZA AND THE COMMON COLD.

Influenza is the commonest of the great epidemic scourges from which we still suffer. As yet we are far from knowing how ultimately we may lessen its incidence or increase our prospects of recovery from it. A detailed description of its varying symptoms is unnecessary; for, unfortunately, nearly every one in this country is familiar with them either at first or second hand. The manifestations of influenza vary a good deal in different epidemics; sometimes the stomach and digestive apparatus are notably disturbed; sometimes the lungs and other respiratory organs are specially attacked; whilst in yet other epidemic invasions, the nervous system stands out as the chief victim. We do not yet know with certainty by what means the virus of influenza spreads. Direct contagion is almost surely one of them; but it can hardly account for the rapidity with which influenza often travels from one country to another—often in almost opposite quarters of the globe—the pace being frequently far greater than that of any contemporary method of human transit. Nor has it been found possible to define with any approach even to probability, what are the atmospheric conditions, humidity, temperature, and so on, common to the several countries coincidently attacked—conditions which might with some plausibility be held to predispose. It has, however, been proved beyond reasonable doubt that the specific provocative agent is an ultra-microscopic virus, the virulence of which presumably varies from time to time according to a number of as yet undetermined circumstances. We know how different in severity and in fatality are successive epidemics of influenza. In England and Wales the mortality rate from the epidemic of 1918–19 in the course of forty-six weeks was 4,774 per million of the population —more than half as big again as that of the great cholera epidemic of 1849.

It is impossible to give any useful advice as to precautionary measures that may be taken against this disease, beyond recommending that

everything be done to keep the body's resilience and reactive power at their highest level of efficiency. When influenza is about, any one who is made aware by a shivering fit, a sore throat, a headache of unusual severity, or a sudden development of *malaise*, that he is likely to have caught the disease, will be wise to go straight to bed, and to remain there until he feels himself again. If his symptoms increase in severity, he should send for a doctor without undue delay.

The common cold is, compared with influenza, of pathologically inferior status. It shares with that disease the distinction of having for centuries baffled, and of continuing to baffle, the persistent efforts of medical science to prevent or master it. It is as widespread to-day as ever it was; and it cannot honestly be said that we are in any better position to resist or overcome it than were our grandfathers. Like influenza, the common cold seems to effect its entry into our bodies through the respiratory passages. If, however, its manifestations and consequences were limited to that symptom, nasal catarrh, which is peculiarly associated with it, there would be small need for concern. Unfortunately, a cold does not always confine its attack to the nostrils, or even to the throat. It is often the starting-point of grave and seemingly remote disorders, and it should never be treated too lightly. The common cold, like influenza, has been proved to be conveyable by means of a filter-passing virus—that is, an entity capable of self-multiplication, so much smaller than any known germ that it will pass through the pores of a fine filter. People who lead active, outdoor lives, feed themselves simply yet well, clothe themselves sensibly but not excessively, and sleep in cool, airy conditions, are found, on the whole, to be those least liable to 'catch cold,' and most successful in overcoming the infection when attacked.

RHEUMATIC FEVER.

Rheumatic fever, or acute rheumatism, has little connection with most of those chronic disorders that are commonly classed as rheumatic. It is, evidently, a germ-caused disorder, in which there is a considerable idiosyncratic element. Popularly, acute rheumatism has been assumed to be related to chronic rheumatic diseases, because it is usually, or often, characterized by a painful swelling of joints. This, however, is by no means a necessary or universal symptom of the disease. Tonsillitis, so-called 'growing pains,' and, as some hold, chorea or St. Vitus's dance, may each be a manifestation of the invasion of the body by the streptococcus now generally assumed to be the specific organism concerned in rheumatic fever. The form in which the disease commonly presented itself thirty or forty years ago, seems now to be much more rarely seen; but the outstanding consequence of an acute rheumatic attack—namely, endocarditis and valvular disease of the heart—

is as much in evidence as it used to be. Prolonged rest in bed is perhaps the most important part of the treatment of an acute rheumatic attack. The management of such a case is always a matter for an experienced doctor. The drug on which physicians most rely is salicylate of soda; but, in dealing with a disorder with such grave possibilities, amateur doctoring is out of place. Whenever a child, or young person, complains of a sore throat, of pains in the muscles or joints, or of swelling in these latter, careful observation should at once be made; and if the symptoms do not disappear within a few days at most, a doctor should be consulted.

The fact that acute tonsillitis is so commonly associated with juvenile rheumatism suggests that infection is usually by way of the throat. It is much commoner among poor children than among those of the well-to-do classes. It can hardly be that poor children encounter germs which studiously avoid rich children; though, of course, the crowded conditions of their homes may subject the former to more heavily germ-laden atmospheres. Again, it is not likely that well-to-do children constitute an innately immune strain; for our class barriers are no longer high enough to prevent constant crossing. We are left with the presumption that there is in the early environment of a large number of working-class children, something distinguishing it from that which almost universally obtains in better-to-do circles, which exposes these children to greater risks or makes them more pathologically susceptible. This would seem to limit the range of potential causative factors to food, clothing, domestic atmosphere, and degree of sunlight. Damp and overcrowding are conditions specially suspect; and they both appear to favour the disease; but deficiencies in diet are perhaps the chief among predisposing causes.

VI—THE ENDOCRINE SYSTEM AND METABOLIC DISORDERS

THE word gland is familiar to everybody, but it is difficult to define exactly what is understood by this term. For our purpose it is sufficient to divide glands into three classes: lymph glands, glands with ducts, and glands without ducts.

LYMPH GLANDS

Lymph glands are rounded bodies set at various points along the course of the network of lymphatics. They consist of masses of small cells called lymphocytes, and their function seems to be to supply these to the blood and to act as obstructions to the spread of an infection. Lymph glands belong to the system of lymphoid tissue, which is widely distributed in the body. Of this the tonsils are well-known examples, and they constitute a barrier against infection entering the system by the throat. Should the tonsils become weakened and infected they may themselves become a source of danger.

It is common knowledge that if a cut in a finger becomes septic and 'blood poisoning' sets in, the glands in the armpit swell and become painful. Similarly with infected wounds in the foot, which affect the glands in the groin. In cases of cancer of the breast the cancerous or malignant processes travel along the lymphatic tracts and so reach the glands, which themselves become malignant. Tuberculous glands in the neck and elsewhere show the response of glands to infection, and confirm the great importance of this system in limiting the spread of disease.

Whilst it is not impossible that these glands produce some secretion which enters the circulation and has some specific effect on the organism, we are unable so far to make any definite statement in this connection, and must be content at present to regard them apart from the glands of secretion.

GLANDS WITH DUCTS AND EXTERNAL SECRETION

This system consists of organs set at various points in the body, the functions of which are to manufacture special products from the blood supplied to them, and to transfer these products, by means of conducting channels or ducts, to the particular place where their properties are of

greatest use. These glands develop as specialized outgrowths from those parts where their secretions will later be required. Among them are the salivary glands, the ducts of which open into the mouth; the liver and pancreas, the ducts of which open into the intestine; the tear and sweat glands, and so on. The stomach and intestines possess specially modified glands for the production of the gastric and intestinal juices. These glands with ducts leading from them produce secretions containing salts, and in many cases enzymes; and these are never carried directly into the blood.

Endocrine Glands

This system of glands comprises the thyroid, parathyroids, pancreatic islets, adrenals, sex glands, pituitary, spleen, and thymus.

These glands possess no ducts; each produces one or more characteristic hormones (internal secretions or chemical messengers) which are discharged directly into the circulation. A hormone is an active chemical substance which exerts a powerful influence upon the general metabolism of the body and, in some cases, on the activity of other glands. This latter point must be carefully kept in mind. For as our knowledge of endocrinology increases it becomes more and more clear that these glands react upon one another, and that diseases of one inevitably produce repercussions on the functions of the others.

Structurally these glands are distinct from one another, and there is no difficulty in distinguishing their characteristic architecture under microscopic examination. Each produces entirely different hormones; we do not yet know how.

THE THYROID GLAND.

This gland lies in the neck close to the windpipe, and consists of two lobes and a more or less well marked isthmus. It is, like all the endocrines, richly supplied with blood, and is made up of a supporting structure of connective tissue and a large number of little bag-like vesicles. In these we find, in the normal gland, a proteinous secretion called *thyroid colloid*, which is rich in iodine. The cells which line the vesicles have the property of abstracting from the blood the amino-acid 'tyrosin' (see chapter on Metabolism), and making it combine with iodine—obtained by the body from outside sources—to form di-iodo tyrosin. From this combination the cells produce the extremely important substance thyroxine, which they pass on into the vesicles where it is stored. Thence, under normal circumstances, it is liberated again at a slow convenient rate into the blood. The gland thus manufactures the specific hormone thyroxine, stores it in its

vesicles in a convenient form, and frees it again directly into the circulation.

Thyroxine contains 65% of iodine, so that if adequate quantities of thyroxine are to be produced iodine must be provided in the food. The thyroxine, when liberated into the blood and thence into the tissues, produces certain effects (which we will soon consider) and in doing so the iodine in its molecule is split off and excreted in the urine, making it necessary continually to replenish the iodine in the body. The consequence of a deficiency of iodine in the diet will be considered when we deal with goitre.

If we wish to understand the function of an organ in so complex a system as the body, one way of doing so is to see what happens if it has had to be removed. Nowadays, when aseptic surgery has become so perfected, it is possible to remove almost any gland, and valuable knowledge has been thus gained. The problem of diabetes was solved in this way. But we must realize that the removal of an endocrine gland may lead to effects, not only due directly to a loss of one hormone, but due also to the overaction of other hormones, since these glands exert a control on one another.

In the case of the thyroid gland the effect of the removal of the gland differs at different ages. It will perhaps be simpler to tabulate the principal effects than to describe them at length.

Effects of Complete Removal of the Thyroid Gland

In the Young	*In the Adult*
Growth is greatly reduced.	Strength is lost
The patient remains sexually infantile.	Sexual life is partly diminished.
Growth of brain power is very slight.	The patient becomes sluggish, and anæmia develops.
Skin is thickened and hair is imperfect.	Skin is dry and hair falls out.
Temperature is below normal.	Temperature is low.
Basal metabolism is very low.	Basal metabolism falls.

Both the young and the adult recover normal existence on taking adequate amounts of dried thyroid glands by the mouth, or by injecting thyroxine, thus showing that it is the deficiency in the thyroid principle which is responsible for all the changes. Therefore, we conclude that the thyroid gland produces a secretion which is necessary for normal growth, development, and metabolism, and for the maintenance of normal adult life. Life can continue for a long time without this gland, but it is life at a low mental and physical level.

In considering the results consequent on removal of the thyroid gland, one striking thing is the fall in heat production or 'metabolic rate,' leading to the conclusion that the thyroid principle or hormone is essential to the processes of oxidation in the body. This view is strongly confirmed when we find that, on feeding animals with considerable amounts of thyroid substance or thyroxine, there follows a very marked rise in the metabolic rate and oxygen utilization, showing that the thyroid substance has stimulated the rate of oxidation in the tissues.

The influence of this gland is manifest in every function of the body, but it must be realized that its distant effects may be indirect, and due to its stimulation of the functions of other endocrine glands.

The control of the thyroid itself has long been a matter of controversy. It was considered until recently that it was controlled by the nervous system, but it is now generally accepted that it is not principally so governed, but is under the control of a secretion produced from the anterior lobe of the pituitary gland.

Diseases of the Thyroid Gland. Although the thyroid may be affected by inflammation and tumours, these are rare and not therefore of general interest. The three conditions of the thyroid most commonly seen are:

1. Simple or endemic goitre.
2. Under-action of the gland or hypothyroidism.
3. Over-action of the gland or hyperthyroidism.

Simple Goitre. This disease is simply an enlargement of the thyroid gland, and is particularly prevalent in districts where iodine is deficient either in the soil or in the food. The administration of iodine in any assimilable form is followed by cure or improvement of the condition.

Failure to obtain iodine may lead to enormous overgrowth of the gland, and consequent interference, through pressure, with the breathing and swallowing functions, but in most cases the enlargement of the gland is moderate.

This form of goitre is most frequent in regions considerably removed from the sea. Sea-water contains relatively large amounts of iodine, and from it the iodine passes into the air, and is thence, directly or indirectly, taken into the body. Marine plants and fish are also very rich in iodine, and are important in the prevention of goitre. But the question seems to be not simply one of iodine deficiency, for this form of goitre is also met with in regions where iodine is present in adequate amounts. In parts of India it has been considered to be due to an infective agent existing in the water, but this is not yet proved. Other factors have been suggested as contributing to its causation, amongst them being a dietary deficiency in Vitamin A (q.v.). Cabbage, sprouts,

and cauliflower have been suggested as contributory causes, as these are known to contain combined cyanides allied to certain others which have been found to produce goitre even when adequate amounts of iodine have been given. But whatever the theory of its causation there is no doubt that iodine given as a routine will usually go far toward curing the condition. The fish in one of the rivers of America possessed enlarged thyroids, but this phenomenon disappeared when small amounts of potassium iodide were added to the river water.

In human subjects the incidence of this endemic or simple goitre is found to be associated with a high incidence of deaf-mutism and mental deficiency, but large-scale experiments have shown that this, too, can be wiped out by adding iodine or iodides to the diet. It is only necessary to add potassium or sodium iodide to table salt in the proportion of one part in two hundred thousand to ensure protection. Iodine may be given in other forms, but this is the simplest and the best. In spite of the relative success which follows such treatment there remains much about the disease which is still very obscure.

This form of goitre is not necessarily accompanied by marked metabolic disturbance, but there are in individual cases tendencies to changes which may lead either to hypothyroidism or hyperthyroidism.

Hypothyroidism is a term applied to those conditions which are due to absence or deficient function of the thyroid. This condition, in various degrees of severity, may be present from birth, arise in very early life, or show itself in middle age. When it is present from birth it is frequently referable to deficient thyroid function in the mother, and the child presents in the main the features described above as occurring after removal of the thyroid in the young. This condition is called cretinism, and can be cured by administration of thyroid gland or its active principle.

When the corresponding condition occurs in the adult we call it ***myxoedema***, which is characterized by a general depression of all the functions, mental and physical, with a marked thickening of the skin and the tissues below the skin. Enormous improvement occurs on giving thyroid gland as medicine. Intermediate stages between these extreme forms and normal thyroid function are also met with, and it is a test of the good physician to detect these types. Great benefit is almost always derived from giving thyroid gland preparations. Help in diagnosis and treatment is obtained by determining the basal metabolic rate (B.M.R.) which in these diseases is greatly depressed, values 50% below the normal being frequent. As treatment progresses the B.M.R. gradually or quickly approaches normal. If the treatment is stopped the conditions recur, a fact which has given to the process the name of Replacement Therapy, since it replaces a substance which the body is unable to produce itself. Giving iodine alone or as potassium

iodide is not of much use in these cases; it is the finished product, the thyroid hormone, which is deficient.

Hyperthyroidism. Too much thyroid hormone in the body leads to a train of well-marked symptoms, which can be brought about by simply adding a certain amount of thyroid gland substance to the diet of normal persons. The patient becomes excitable, loses weight, and develops tremors in the limbs; the heart beats quicker than normal, and the general metabolism of the body is greatly increased.

Many of us are familiar with the disease-picture of a rather young person (very frequently a girl) who complains of being 'very nervous,' whose limbs tremble a good deal, who looks rather flushed and is easily excited, who complains of palpitations, and whose eyes tend to bulge, so that she looks perpetually somewhat scared. This is the group of symptoms characteristic of what we now call hyperthyroidism. It is still often called exophthalmic goitre, but recent observations have shown that many of these cases have either no goitre in the neck, or no bulging of the eyes, so that the older term is unsuitable. The whole picture of hyperthyroidism is not frequently met with, but lesser manifestations of it are relatively common. Probably most people who complain of being 'highly strung' or 'nervous' are suffering from some degree of hyperthyroidism.

What is the complete picture of severe hyperthyroidism?

Not uncommonly it begins suddenly, and in youngish people; the subject becomes very nervous, and develops palpitation; in many cases the thyroid gland in the neck becomes enlarged, and its throbbing can be felt with the hand; the patient loses weight, complains of sweating, trembling, and great fatigue. He or she may have gastro-intestinal trouble; may vomit (a bad sign), whilst there is always a great rise in basal metabolic rate. The last point is very important in diagnosis, for of all cases showing a rise in B.M.R. the hyperthyroids constitute 90%. The state of a patient in a well-established severe case is pathetic; he or she lies in bed with a wild stare in the eyes, the heart beating at a rate which is often uncountable, the body shaking with tremors, whilst the slightest disturbance or shock sets up a condition of panic. What is the cause of all this? We know that it is associated with an over-acting thyroid gland, but what sets the over-action going? Quite frankly, we do not know. There is no doubt that there is often a history of a sudden shock or fright or emotional crisis before the onset of the disease. It has been known to arise after a disappointment in love. Sometimes we find a history of disease, but this is probably only a contributory cause. A constitutional factor is also suspected, but the whole subject is very obscure.

It seems probable that there is no single cause, but that a whole concatenation of circumstances suddenly conspire to break down a

weak link in the endocrine chain. There is no doubt, however, that the removal of part of the thyroid gland is followed in a short time by a great improvement. Until recently such an operation was undertaken by the surgeon only with great trepidation, because it was found that patients often died after what seemed like a very good piece of work. Nowadays things are much improved, and success is obtained in the vast majority of cases. The secret lies in what seems at first a paradox. The routine is this. The patient is put to bed, tended very carefully and completely rested: the basal metabolic rate is then determined. This is found to be very high; and for a few days a daily dose of a few drops of an iodine solution is given. It is now found that the patient is much improved, and the basal metabolic rate, instead of being 50% or 80%, is 20% or 40% above normal. At this point the surgeon is called in: he operates, and if proper care is taken after the operation, all is well. Nobody is very clear as to how this is brought about, but one thing is certain; when the removed gland is studied microscopically it is usually found to present features which are very nearly normal and the immense discharge of active thyroid hormone has been stopped. The iodine treatment described above is sometimes tried without operation, but its results are contradictory. Still, there is little doubt that the time is not far distant when this dread disease will come under the control of some purely medical form of treatment, without the help of the surgeon.

THE PARATHYROID GLANDS.

The parathyroid glands are four in number and lie in close contact with the thyroid gland, so that complete removal of the thyroid will, unless special precautions are taken, result in removal of the parathyroids also. Loss of the parathyroids alone is followed in mammals and in birds by a characteristic condition called.

Tetany. The symptoms of tetany are in general due to a great hyperexcitability of nerves: there occur spasms in the muscles of the jaw and face and peculiar contractions of the hands and feet: tremors and fits of convulsions occur in varying degree in different animals. In a few days death follows. For many years we had no definite knowledge of the function of the parathyroids, but chemical investigation of the blood has shown that when the calcium content of the blood falls to a certain level, symptoms exactly like those mentioned above occur. Calcium exists in the blood only in the fluid part, that is, in the plasma, not in the red cells, and the total amount is very small.

When parathyroid tetany occurs it is found that the plasma calcium falls to about one-half the normal, and if soluble calcium salts are injected into the blood the symptoms disappear and the animal for a time is better.

It seems, therefore, that the parathyroid glands in some way control the amount of calcium in the blood, and investigations have been carried out to see if these glands produce an active substance or hormone which, when injected into the animal, can prevent the consequences of loss of the parathyroids. Chemical investigation of the glands of animals showed that such an active principle could be obtained, and it has been named parathormone.

This substance (which has not yet been isolated in the pure state) can prolong life when the parathyroids have been lost.

We have already referred to the importance of keeping the saline composition of the blood satisfactorily balanced and have shown that proper functioning cannot be carried out if this balance is disturbed. In so far as the calcium salts are concerned, the parathyroid glands are clearly involved in this adjustment. Recent work has shown that they are also probably closely concerned with the maintenance of the balance of phosphates in the blood.

Calcium salts are taken both in food and in water. They are found in almost every organ in the body but mainly in the bones, and are excreted in the faeces and urine. Bone and tissue calcium seem to be in a constant state of flux. Normally the blood calcium is very constant, even when the patient is starved.

If the parathyroid hormone is injected into a patient with tetany, the blood calcium is raised to normal values, whilst a similar injection into a healthy individual leads to a rise in blood calcium far above the normal level, in some cases rising to twice the normal percentage. Just as a severe train of symptoms occurs with a great fall in blood calcium, so now the excessively high percentage leads to dangerous results. Congestion and haemorrhage in the stomach and intestine, and even death, follow.

Clearly this hormone is a very powerful one, but opinion as to how its effects are produced is not entirely unanimous. The simplest theory is that it acts directly on the bones, where it stimulates cells which liberate calcium from the bone into the blood. The importance of these glands has been recently stressed during the investigation of a peculiar disease called *generalized osteitis fibrosa*. This condition is a powerful, progressive disease of the bones which leads to fractures, deformities, and marked loss of calcium from the bones. Until lately little could be done with such cases, but it is now known that they are due to tumours of the parathyroid glands with resultant *hyperparathyroidism*. The consequence of this condition is the liberation of calcium from the bones in greater quantity than usual; the calcium in the blood increases and is carried off in greater amount by the urine, or it may be deposited in other parts of the body, such as the kidneys. Bone consists largely of calcium phosphate, so that when

the calcium is liberated from the bone a parallel loss of phosphate occurs. Good results in the treatment of osteitis fibrosa are reported from the removal of the parathyroid tumours.

Tetany in Cows. Milk is rich in calcium and phosphorus; hence it follows that during lactation there will be a considerable drain on the calcium and phosphate of the tissues. In the cow whose milk production has been artificially increased, this drain may be very great, and it is not surprising that it should sometimes give rise to symptoms of illness. Farmers call this condition of tetany 'milk fever,' and in some animals it is a source of great trouble. The cow develops convulsions and cannot stand, and unless immediate remedial measures are taken it will die. Certain cows are liable to this illness every time they calve, and wise farmers are prepared for its appearance. In most cases the cure is simply to blow up the udders with air so that the production of milk is stopped, the calf being artificially fed in the meantime. 'Milk fever' seems to be a tetany due to low blood-calcium content, following on excessive drainage of calcium from the body.

THE PANCREATIC ISLETS OR ISLANDS OF LANGERHANS.

The pancreas lies under the stomach, and is composed of two kinds of gland tissue. One part is responsible for the external secretion of the pancreas or pancreatic juice, which flows into the pancreatic duct, and so enters the small intestine; the other part consists of groups of cells or 'islets' (named after Langerhans), which produce an internal secretion called *insulin*, which enters the blood directly. Insulin is the hormone necessary for the proper metabolism of sugar. We have already discussed the metabolism of sugar, and pointed out that if this goes wrong the whole process of metabolism goes wrong. Let us consider the sequence of events in a normal man when we give him a sugar solution, say fifty grams of glucose. Before he takes the sugar his blood contains about one hundred milligrams in every one hundred cubic centimetres of blood. Let us express this fact by saying that his blood sugar is one hundred. He drinks the sugar solution, and in about an hour his blood sugar is about one hundred and sixty. In two hours or so his blood sugar is back to one hundred, or even less. There is still plenty of sugar being absorbed from the intestine, but his blood sugar is not raised. To deal with all that this simple experiment proves would involve too many technicalities. We can content ourselves with the statement that such a reaction to a dose of glucose is normal.

In the person with a defective insulin secretion, the sequence of events is quite different. Firstly, the initial blood sugar is higher than normal, it may be as high as three hundred or four hundred instead of one hundred. Secondly, the rise in blood sugar, when the solution is

taken, instead of being only sixty or so, may be two hundred or more. Thirdly, instead of returning to its initial level in two hours, the blood sugar keeps up at a very high level for several hours. Put briefly, the blood sugar is much higher to start with, rises to a much greater extent, and stays high for a much longer time. This is the characteristic reaction of a diabetic. When the blood sugar of a man rises above one hundred and eighty, the sugar passes from the blood into the urine, and this concentration of sugar in the blood is the condition called *glycosuria-threshold*—the point at which sugar passes out. Analysis of the whole phenomena has taken many years of research, and it may now be considered certain that it is the insulin from the pancreatic islets which keeps blood sugar normal and prevents the passage of sugar into the urine. When sugar is taken by a normal man the blood sugar rises to a level which, in that particular individual, stimulates the islets to secrete insulin. This passes rapidly into the blood and tissues, and prevents any further rise in blood sugar by means of two processes; first, the stimulation of the muscles to burn up the sugar; and secondly, the stimulation of the liver to store the sugar in the form of glycogen.

In a diabetic human being these processes are more or less defective according to the severity of the disease. In any case sugar is lost by the urine, and in the more serious forms of the disease all the sugar taken may be discarded in the urine. The two outstanding characteristics of diabetes are inability properly or completely to burn sugar; and inability to form glycogen. In the diabetic patient the injection of insulin restores the power to burn sugar and to form glycogen, but this re-establishment of function only goes on as long as sufficient insulin is injected. Insulin treatment is a replacement therapy, and not a cure. As long as the patient has diabetes, insulin must be continued in proper dosage. Furthermore, insulin must be injected by means of a hypodermic needle, because if taken by the mouth it is destroyed. The points raised in the consideration of diabetes and insulin are so many that we can only choose a few of the more outstanding, and give a short account of them.

Hyperglycaemia. This is the term used to denote a condition in which the sugar in the blood is greater than the normal. The diabetic patient has a persistent hyperglycaemia, and this leads to *glycosuria.* Insulin in proper dosage prevents hyperglycaemia. Insulin in too great dosage leads to too heavy a fall in blood sugar, so that concentrations result which are too low to maintain life.

Hypoglycaemia. If too large a dose of insulin is taken, or if the insulin is allowed to act unsupported by an adequate diet, the blood sugar may fall to very low levels. Should it fall to half the normal concentration, or less, a series of unpleasant symptoms is experienced,

and the patient may even become unconscious and pass into coma. This is called hypoglycaemic shock, and can be rapidly neutralized by the immediate taking of sugar. Every diabetic patient using insulin should carry some sugar with him in case this condition should occur.

One of the outstanding symptoms of diabetes is loss of weight. This loss will occur in the untreated diabetic no matter how generous his diet, and is due to the following fact. The untreated diabetic passes large quantities of sugar in his urine, and this comes not only from his food, but also from the breakdown of his own tissues. This process of forming sugar from the tissues is called *gluconeogenesis*, and in normal life is a normal process, but in diabetes it gets out of control, and in severe cases the patient loses weight rapidly. Insulin stops this uncontrolled gluconeogenesis so effectively that the patient soon begins to gain weight and strength, and can resume his usual work.

In very severe cases of untreated diabetes the patient may develop what is called *diabetic coma*, that is, become unconscious and suffer from 'air hunger.' The cause of this has been very much debated, but the most commonly held opinion is as follows. The failure to burn sugar properly results in failure to burn fat properly. As we have seen earlier, fats are normally burnt away to carbon dioxide and water, leaving no residues. In diabetes, however, the fatty acids are not burnt away without residue; certain substances are produced which the body cannot consume until insulin is given. These substances are acids, called diacetic acid and hydroxybutyric acid; they circulate in the blood of the diabetic patient, and are passed out into the urine. This acid-loaded condition is called *ketosis*, and if the ketosis is very severe the poisonous effects of the acids on the brain lead to coma and, if measures are not taken, to death. Ketosis disappears when the metabolism of sugar is restored to the normal by the injection of insulin.

The fundamental cause of diabetes is unknown, perhaps because there is no single cause. People who have for a long time eaten sugar to excess often develop diabetes; whilst there is probably some hereditary factor, since the disease tends to run in families. There may also be a contributory nervous condition, and recent research has shown that the pituitary gland, which lies at the base of the brain, produces a secretion which opposes the action of insulin. Other glands may be involved, possibly the thyroid, since it is found that hyperthyroidic patients often pass sugar in the urine. The adrenal glands, also, produce a secretion, adrenalin, which, when injected, leads to the appearance of sugar in the urine. Hence it may be assumed that, although diabetes can be completely controlled by insulin, the disease is probably in its origin polyglandular, that is, produced by disturbances of the equilibrium of several glands, of which the principal are the pancreas, the pituitary, the thyroid, and the adrenals.

One final point about insulin may be of interest. This hormone is sometimes used in the treatment of cases of loss of weight, loss of appetite, and certain nervous complaints, even though these may not be of obvious diabetic origin. A small dose of insulin is given once or twice a day, and this will, in some cases, stimulate the appetite, improve the general health, and increase weight.

THE ADRENAL GLANDS.

These two glands are situated one on either side of the abdomen in more or less close proximity to the upper parts of the kidneys. They are roughly pyramidal in shape, and consist of an outer rind or cortex, and an inner core or medulla. The two parts of the gland are distinct in structure, in development, and in function; and each part produces a characteristic internal secretion or hormone. That of the cortex has recently been discovered, and is called cortin; that of the medulla is called adrenalin, and has been known for a good many years.

The loss of both these glands leads in mammals to a characteristic train of symptoms, in many respects similar to that of the disease called *Addison's disease.* This disease is generally due to a tuberculous infection of the adrenal glands, and is fortunately rather rare. The symptoms are very striking. The patient becomes weak, loses appetite and weight, suffers from intestinal disturbances, and develops a dark pigmentation in the skin and on the palate: the blood-pressure falls to a very low level, and the blood sugar is also very much below normal. Inevitably death ensues in a short time.

It has been a question whether the symptoms are due to deficiency of the hormone of the cortex, or of that of the medulla, or of both. The injection of adrenalin produces only a very slight temporary relief, even when large doses are used, and lately it has been shown conclusively that it is the cortical hormone which is essential in the alleviation of the symptoms of Addison's disease, and of those following removal of the glands. Methods of extraction of cortin are still somewhat imperfect, so that large doses are at present necessary, but there is no doubt that the pure hormone will soon be available. The actual function of cortin in normal life is still being traced, but it would seem that its main importance lies in the regulation of the interchange of water and certain salts between the blood and the tissues.

We have already referred to the other secretion of the adrenal glands, adrenalin. This substance is of the highest importance. Although it is mainly produced in the adrenal medulla, it is widely distributed throughout what is called the autonomic nervous system. This system may be roughly defined as a specially developed system of fibres and ganglia, which carries the messages that control the functions of the internal organs. It is divided into two great groups, one arising

from the brain and lower end of the spinal cord, called the parasympathetic; one arising from the thoracic and lumbar spinal cord, called the sympathetic. The action of adrenalin is, generally speaking, to stimulate the sympathetic.

These two divisions of the autonomic are in continuous action, producing opposed effects, so that in the normal subject there is a constantly shifting balance between the two. The heart is slowed by the parasympathetic, and accelerated by the sympathetic; during excitement or fear there is a release of adrenalin; this stimulates the sympathetic, and the heart beats faster. The intestine is stimulated to contract by the parasympathetic, and to relax by the sympathetic; thus conditions leading to an increased production of adrenalin, among which is the emotion of fear, will produce a loosening of the bowel. The pupil of the eye is partly under the control of the parasympathetic and partly of the sympathetic, the former tending to contract the pupil and the latter to dilate it: hence fear and rage lead to a dilatation of the pupil.

The release of sugar from the glycogen in the liver is partly under the control of the sympathetic, so that during emotional disturbance, with the increased circulation of adrenalin there is an increased release of sugar, and hence a rise in blood sugar. The injection of adrenalin in fairly large doses will lead to the appearance of sugar in the urine.

The calibre of the smaller arteries is controlled through fibres arising from the sympathetic. Stimulation of such fibres by adrenalin leads to a constriction of these blood-vessels, and hence to a greater resistance to the blood-flow. The heart has to exert a greater force to pump the blood, and the blood-pressure rises. Here we see the importance of this hormone in the control of the blood-pressure; and in the maintenance of an efficient circulation. Other factors in this control are discussed in the section on the circulation, but it has been suggested that in cases of high blood-pressure the root cause of the condition is an over-activity of the medulla of the adrenal glands.

THE SEX GLANDS.

Although it was long suspected that these glands manufactured hormones, it is only in very recent years that any certain knowledge of this has been obtained. And even now, most of the work of research has been carried out on the female sex glands and their hormones, because the technique of testing their active extracts is easier. Our conception of sex is closely linked with that of reproduction, and we shall not err much if we regard sex glands and sex hormones as biological mechanisms for making easy and efficient the processes of reproduction of our species.

The sex glands (ovaries and testes) possess the double function of

producing the cells from which the new individual is to be developed, and the substances or hormones which make possible the successful union of the male and female cells. The former are, of course, the spermatozoa from the male, and the ova from the female. The mating of many animals is only possible at certain times, because except in the time of oestrus or heat the female will not receive the male. The rat and mouse will only receive the male every five or six days, whilst the guinea-pig will only do so every fifteen to seventeen days. The occurrence of such oestrus cycles depends on the presence of the hormones of the ovary in the female, and is manifested by definite and recognizable changes in the genital tract. In the periods between heat the vagina is not in a condition to receive the penis of the male: in the guinea-pig it is actually closed by a membrane during these times. During oestrus the vagina opens, its walls become turgid with blood, and its cells become harder, and it secretes a lubricating mucus. This period corresponds to that in which the ovum is discharged from the ovary. In an animal from which the ovaries have been removed the oestrus cycle is abolished; so that not only does it no longer produce ova, but it will not receive the male, that is to say, it does not go into heat. Such an animal is called a castrate. If we inject into such an animal certain extracts of the ovary from—say—the pig or the cow, it is found that the oestrus cycle can be re-established in all its phases. The substance or hormone responsible for this is oestrin, and is a definite chemical compound. It is present in human female blood and urine as well as in those of other animals.

Consider the ovary for a moment. When the ovum has been discharged from its follicle or shell on the ovary, the space is soon filled with blood; and this blood undergoes certain changes which transform it into a more or less yellow pigment. This yellow-pigmented follicle is called a corpus luteum, and is of great importance. It secretes a hormone which has a special action on the wall of the uterus. The secretion of the corpus luteum may be called the hormone of nidation, or nest-making hormone. The uterine lining thickens, becomes rich in blood-vessels, and is in other ways prepared to receive the fertilized ovum. What happens next depends on whether or not the ovum is fertilized by the spermatozoon, i.e. whether a young animal is going to develop or not.

If fertilization does not take place the ovum degenerates, the corpus luteum degenerates, and the prepared lining of the uterus is thrown off and is got rid of by menstruation. Menstruation may be regarded as a protest against non-fertilization.

If fertilization does take place the ovum and spermatozoon unite together into what finally becomes the offspring, this union and development taking place in the uterus. In such a case the corpus luteum

persists, and grows, and may even come to occupy one-third of the whole ovary. This persistent corpus luteum is called the corpus luteum of pregnancy, and its removal leads to the termination of the pregnancy, that is, either the developing infant is expelled or it degenerates. It would seem, therefore, that the corpus luteum produces some internal secretion, which is essential for the establishment and continuance of pregnancy. As long as the corpus luteum persists, the mother does not release any more ova from the ovary, and will not menstruate, showing that the action of the corpus luteum is to oppose ovulation and menstruation. In addition to these functions, it controls the growth and development of the mammary gland during pregnancy, bringing it to a state in which it can produce milk.

These functions of the ovary and the corpus luteum are themselves dependent on the proper action of the pituitary gland with which we shall deal next, the anterior lobe of which produces a secretion which controls the activity of these bodies. In the urine and blood of a pregnant female it is possible to detect a substance similar to that produced by the anterior lobe of the pituitary, and perhaps identical with it. The presence of the 'anterior-pituitary-like' substance in the urine can be shown by injecting extracts of the urine into immature mice, that is, mice which normally could not yet develop oestrus, when in a few hours the animal will develop unmistakable signs of ovarian activity and corpus luteum formation. By this test we can ascertain whether a woman is pregnant, as it gives reliable results before there is any evidence of pregnancy discoverable by external methods of examination. This substance is, of course, present during the ordinary ovarian cycle, but the increase is so great during pregnancy that detection is positive with much less material. This test is now a routine in hospitals and clinics, and very rarely gives misleading results.

The male sex hormones are equally important. The removal of the testes from any male animal is followed not only by the loss of fertilizing power, but also by the loss or modification of the characteristics associated with the male sex. The physical appearance of the eunuch is well known, while the production of 'castrati' in the Middle Ages and later, in order to retain the treble voices of young male singers will also be recalled. In young castrated rats the penis and accessory organs of generation remain infantile, and the young cockerel, if deprived of his testes, does not develop the large red comb, wattles, and barbels which we associate with the full-grown cock.

There is now no doubt that the testes produce a substance, which appears to be identical in all species and is allied in composition to oestrin, which re-establishes the male characteristics of the castrated male. The implantation of testicular tissue will produce similar results. It should, however, be remembered that the re-establishment

of the male characters in a young castrated animal is not the same as rejuvenating an aged subject.

THE PITUITARY GLAND.

The pituitary is a small gland weighing about half a gram. It lies well protected in a depression of the sphenoid bone at the base of the brain. The influence of this tiny organ upon the most diverse processes in the body is almost incredible. In the human subject it is composed of two principal parts, the anterior and the posterior lobes. Microscopically, the anterior lobe is composed of cells which are arranged in gland form, but the posterior lobe is composed of cells, closely resembling nervous tissue, from which we should not ordinarily expect a secretion.

The Posterior Lobe. This is the easier to consider briefly, because so far as is known it produces only two active principles. Until lately it was thought that it produced only one active body, pituitrin, but this has now been split into two distinct compounds called pitressin and pitocin. In ordinary medical work the combination of the two as pituitrin is commonly used. The three results which it brings about correspond with the natural functions of the posterior pituitary. It is used in medicine:

(1) In raising the blood-pressure in cases of heart failure and collapse, showing that the posterior pituitary is one of the controllers of the blood-pressure.

(2) In the treatment of cases of *diabetes insipidus.* In this condition enormous amounts of urine are produced and correspondingly enormous quantities of fluid are drunk. This disease is distinct from ordinary or sugar diabetes. Sugar is not found in the urine of sufferers from diabetes insipidus. It is probably due to a depressed activity of the posterior pituitary, and adjacent parts of the brain. The injection of pituitrin is very helpful, and in some cases leads to complete control of the symptoms.

(3) In the delivery of pregnant women. In the later stages of labour when there is no obstruction to delivery, but the womb does not contract strongly enough, the injection of a relatively small dose of pituitrin will produce strong contractions, and the child is often expelled very quickly.

There would seem to be little obvious connection between a small gland at the base of the brain and the control of the contraction of the womb and the formation of urine. This should remind us again of the close connection between nervous action, emotion, and organic function. The mind probably exerts no small control over the functions of the endocrine glands. Every doctor knows how much

easier some confinements are than others which appear physically similar, and it is possible that the mental attitude in the one case may stimulate the activity of this important gland, and so produce sufficient pitocin to contract the womb effectively.

The Anterior Lobe. This is composed of three types of cells in a gland-like arrangement. The distinction between these cells is one which can only be established by the microscope. They are called according to their readiness to stain with certain substances: chromophobe cells, acidophil cells, and basophil cells. More than in the case of any other gland, our knowledge of the anterior pituitary has been obtained from the study of human disease by correlating such disease with changes found in the gland after death. The result is that we can now state with some confidence what particular function is performed by each type of cell in this part of the gland.

The acidophil cells produce a hormone which stimulates the growth of the body in general, but particularly that of the bones and muscles. This growth-promoting action has been shown by the preparation of extracts of the anterior pituitary, which have produced in treated rats enormous overgrowth.

In the human species we meet, now and again, with examples of giants and dwarfs. These unfortunate abnormals are generally found as exhibits in shows and fairs. The X-ray photographs of the insides of the skulls of these subjects show in giants definite evidence of an enlarged pituitary gland, and of the reverse in dwarfs. A peculiar disease called acromegaly gives further proof of this function of these cells. This ailment attacks the patient slowly; his limbs and the bones of his face become enlarged and thickened; the tongue swells, the lower jaw becomes prominent and gradually the whole individual changes. Sex-life ends, and he becomes impotent. If the condition arises before the subject is full-grown he may develop into a giant, but an unhealthy one. Sometimes sugar diabetes accompanies this disease. Acromegaly has been definitely shown to be due to a tumour of the anterior pituitary, composed of acidophil cells. Surgical removal of such a tumour is very difficult, but in certain cases it has been successfully done with marked improvement. The growth of such a tumour, apart from producing excessive overgrowth of the body, also interferes with the function of the other parts of the gland.

The basophil cells elaborate an active principle which controls the activities of the ovaries and the testes. Failure of these cells to develop leads to a cessation of the development of sex characters, and we get what is called sexual infantilism. The proper establishment of the sexual cycle of oestrus and of the corpus luteum are directly dependent on the basophil cells of the anterior pituitary. Thus we may see how overgrowth or tumour of the acidophil cells in acromegaly, with its

consequent compression of the basophil cells, may lead to disturbances of sexual function and to impotence.

The function of the chromophobe cells is at present unknown. In certain cases of tumour and overgrowth of these cells there may follow compression of the other elements of the anterior pituitary and consequent dwarfism and maldevelopment of sex. Such tumours often lead to impairment of vision, since the pituitary gland lies in close relation with the optic chiasma, that is, the crossing-place of the optic nerves.

Recent research has demonstrated that the pituitary exerts control over the thyroid, and the adrenals, and also produces a hormone which antagonizes the action of insulin. The whole subject of the ductless glands is of vast complexity, and we can only state here that the entire life of the organism seems to be regulated by an interplay of a great number of chemical agents, produced by special glands, and so balanced one against another that what is called normality results. In the complicated interactions the pituitary may be called the master gland.

VII—THE SPECIAL SENSE ORGANS AND THEIR DISORDERS

THE EYE

THE human being who has lost his sight is very heavily handicapped in the competition of life, and, as the necessity for a broad field of vision presupposes that the organ of sight must be placed on the surface of the body in a relatively exposed position, it will not be found surprising that it is a very complicated mechanism, and includes several devices, such as eyelids, tearducts, etc., which are designed to protect it from damage from trivial causes. These protective devices will be described later, after the eye itself has been dealt with. In addition to the eye, the apparatus of sight includes the optic nerve and the occipital lobes of the brain. Briefly, the process of seeing is as follows: The eye forms pictures of the objects in its field of vision, the optic nerve then carries these impressions to the brain where they are received and interpreted, and the messages they convey are passed on to the body if necessary. We each possess two eyes, identical in function, though individual variations in the working of the two eyes occur with great frequency. Each eye registers the same picture, and transfers it by the same process to the brain, where the two impressions are correlated and interpreted, each strengthening and supplementing the other. The two eyes are situated in deepish hollows in the front of the skull at each side of the head. These cavities, or orbits, as they are called, are designed to form protection for the soft and easily damaged eyeball and its accompaniments, such as the optic nerve and the muscular tissues which serve to move the eyeball in different directions. The bone of the margins of the orbits is very strong and can withstand a hard blow which would destroy the eye if it were not thus protected. The general structure of the eye is described elsewhere in this book. Here it is proposed to summarize such of the facts as will help to make clear what follows.

THE EYEBALLS.

The eyeball is the major part of the eye. It is ball-shaped with a slight bulge in the front. This bulge is called the *cornea*, and is the window of the eye through which the picture-images of the outside world come. In a healthy state the cornea is a perfectly transparent

membrane. Underneath the cornea lie the *iris*, or coloured part of the eye, and the *pupil*, or black centre of the eye, which is simply a round hole in the centre of the iris. The eyeball is covered by three layers of tissue. The outer layer, which is called the *sclerotic*, covers the entire surface of the eyeball. It is composed mainly of firm white opaque tissue, from which it takes its popular name of the 'white of the eye.' At the front of the eyeball, however, this tissue undergoes a change in composition, becoming transparent instead of opaque, and this transparent tissue forms the *cornea*. The cornea should be perfectly transparent if it is to carry out its function of transmitting rays of light. In order to ensure that no irritating substance or foreign body shall remain on its surface long enough to impair it, the cornea is well supplied with minute nerve-fibres, and therefore very acute pain is caused when anything alights on its surface, or finds its way under the upper lid. This pain usually ensures that immediate steps will be taken to remove the cause of irritation.

THE AQUEOUS AND VITREOUS HUMOURS.

The eyeball is divided into two parts, with the lens as the dividing wall. Each division contains fluid or jelly-like matter in cavities. In the front cavity of the eye, between the iris and the lens, the fluid is clear and thin, and is known as the aqueous humour. It is of the greatest importance in maintaining the proper balance of pressure in the eyeball. A drainage canal, known as the canal of Schlemm, acts as an overflow reservoir to avoid undue increase of pressure. In the rear cavity, which is the larger of the two, and lies behind the lens, the fluid substance is of a firmer and more jelly-like consistency. This substance is known as the vitreous humour. It is sparkling and transparent, and plays an important part in the process of the refraction of the rays of light.

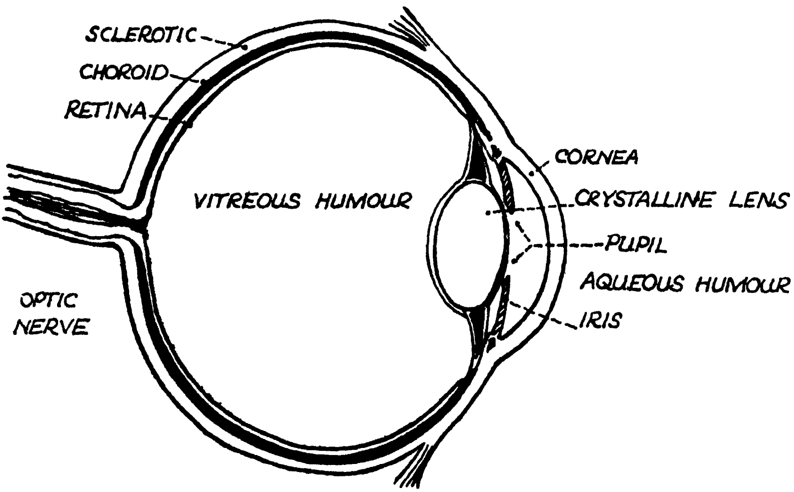
THE CHOROID.

The second layer of tissue in the eyeball is called the choroid. It contains much colouring matter, and is permeated with blood-vessels. The black pigment in the choroid serves to absorb the diffuse rays of light, which would otherwise dazzle the sight, and confuse the images observed. This dark pigment is absent in the persons and animals known as albinos, and it is well known that their sight is very dim and defective. This is especially so during the day, when they are in a state of dazzlement by the strong rays of daylight. In twilight they can usually see slightly better. As the choroid reaches the front of the eye it becomes thickened and raised up into numerous tiny ridges, which are called the ciliary processes, or ciliary body. These ciliary processes

consist of blood-vessels and circular muscles, and they form a circular rim to the iris, into which the choroid merges in the centre of the eye in the same way that the sclerotic merges into the cornea in the outer layer of the eyeball. The iris, or coloured part of the eye, acts as a light regulator for the pupil through which light passes into the eye. The circular muscles allow the pupil to be contracted or expanded according to how much light it is desirable should enter the eye. The pupil is, as has been stated, merely a circular gap in the tissue of the iris. It appears black because of the dark tissue behind it.

THE LENS.

Immediately behind the iris is found the lens. As its name suggests, its purpose is to focus the rays of light which enter the eye and throw them upon the retina, which lies behind in the third layer of tissue.



DIAGRAMMATIC SECTION OF EYE

The lens is composed of crystalline transparent material, and is enveloped in a capsule. This capsule is formed of elastic tissue, and continues from the lens to the ciliary processes, so that the lens, which is a double convex body with the larger convexity to the back, can be said to be suspended in the depths of the eye. The action of the ciliary muscle and the elasticity of the suspensory tissue allow the lens to become more or less convex as required in order to focus objects at different distances. This power is called the 'power of accommodation,' and it is to correct defects in accommodation that most people obtain spectacles, especially as they grow older and the ciliary muscle begins to fail.

THE RETINA.

The third layer of the eye is that formed by the retina. This is the most delicate and intricate layer, and is composed of cells of very specialized tissue, which forms the ends of the optic nerve-fibres. These fibres enter the eye at the back in a large bundle, and then spread out in every direction and form a membrane covering the surface of the choroid. The structure of the retina is very complicated. The cells of which it is composed are of a variety which is found nowhere else in the body, and their special characteristic is their sensitivity to light. In shape, the most important groups of cells are minute elongated cells, which are known as the rods and cones. These are found in the deepest part of the retina, and are attached to the fibres of the optic nerve, which carries the impressions of light to the brain. It has been discovered by means of the microscope that the tissue of the retina is at least nine layers deep, so that a ray of light passes through many processes before it is finally collected by the rod- and cone-shaped cells, and transferred to the brain to become an impression of sight.

Not all parts of the retina are equally sensitive to light. The midpoint is the most sensitive area. On examination with a powerful lens this area appears as a yellowish stain, and is called the macula or macula lutea. The spot where the optic nerve enters the retina is quite insensitive, and is known as the optic disk, or in popular language, the 'blind spot.' The instrument by means of which the eye of a living person can be examined is called the opthalmoscope. When seen through the opthalmoscope the retina appears bright ruby red, with the yellowish macular area in the middle, and the pinkish area of the optic disk at one side. From the optic disk, blood-vessels radiate in every direction to the different parts of the retina, and the nerve-fibres of the retina come together to form the optic nerve.

THE WORKING OF THE EYE.

To recapitulate: The eye is very often compared to a camera. A camera is used to collect impressions of objects and focus them on to a plate, from which the impressions are printed off on to paper, when they can be seen. The eye similarly is used by us to gather impressions of the external world and focus them by means of the lens on to the retina, whence they are conveyed to the brain, which performs the acts of interpretation which allow us to 'see' them. The choroid may be compared to the box or black cloth which cuts off the reflection of light which would otherwise spoil the clearness of the picture. The iris acts as the stop and shutter, allowing the pupil to open more widely in a poor light, and closing it when sufficient light is entering. The lens focuses the objects to be seen, and throws them on to the retina.

In addition to the different parts of the eye itself, there are many

muscles and nerves required for its effective use. These allow the eye to move from side to side, up and down, and with a circular movement; thus ensuring a very large field of vision. In view of the fragility of the various structures of the eye, the nerves of sensation with which most parts are well supplied are very sensitive, so that any damage to the eye is apt to be very painful. Moreover all parts of the eye are plentifully supplied with arteries and veins, so that it shall be properly nourished. Because of this network of delicate vessels the state of the blood-circulatory system is of great importance to the eye. Increased blood-pressure, causing intra-ocular tension, can have very serious effects on the sight, as in the case of the disease known as glaucoma.

In order to have good eyesight, it is necessary that the cornea and retina shall be clear, and that the eyeball shall be well shaped. Otherwise, such irregularities as myopia, hypermetropia, and astigmatism will be present. The apparatus dealing with accommodation must also be in good working order. There are comparatively few perfect eyes in the world, but a great many people manage very well throughout life with a small degree of imperfection, and many of the others have their faults corrected by the use of glasses.

THE EYELIDS.

The eye is protected behind and at the sides by the bone of the skull, and in front by the eyelids. These are two flanges of skin strengthened by a thin sheet of cartilage and lined with mucous membrane. This membrane is called the conjunctiva, and the mucus it excretes from its glands serves as an oiling fluid to enable the eyeball to move easily and without friction in the socket. The eyelids protect the eyeballs from too great exposure to the light, and from damage by external objects, such as dust particles, blows from raindrops, etc.

THE TEAR GLANDS.

In the upper and outer part of the eyeball are the lachrymal or tear glands. These produce the salty fluid which we know as tears, and help to keep the eye moist and clean. These glands pour out fluid which bathes the front of the eye, and flows away into little canals called the canaliculi. The canaliculi have their openings at the corner of the eyelids near the nose. They lead to a little bag called the lachrymal sac, and from thence pass into the nose. This forms a neat and complete system of washing and draining for the eye, but when a thorough sluicing-out is required, as in the case of dust in the eye, a larger quantity of fluid is poured out than the tear sacs can collect at the moment, and we have the phenomenon of tears flowing down the face. If the tear ducts become blocked there may be a temporary state of 'watering of the eye.' If this becomes chronic it will have to be remedied by a slight operation. The tears

contain sodium chloride, or common salt, which has a slight bactericidal action, so that they protect the eye in some measure from the danger, to which it is constantly exposed, of infection by bacteria-laden dust.

Disorders of the Eye and Eyelids

BLINDNESS.

When the power of sight is destroyed, a person is said to be blind; but there are many degrees of dimness of sight short of total blindness. A certain number of persons are born blind, and if their blindness is due to structural defects there may be nothing to be done for them, but a large proportion of the children who are labelled blind from birth could have been saved this misfortune with proper care and treatment in the early days of life. Blindness is often due to inflammation of the eyes which is present at birth, or arises shortly after, and is not properly treated. This ophthalmia neonatorum, as it is called, can usually be cured or avoided if reasonable antiseptic precautions are adopted at the time of birth and afterwards, especially when it is known that the mother has a vaginal discharge with which she is likely to infect the child.

Any disease which causes the transparent parts of the eye, such as the cornea and the lens, to become opaque, diminishes or entirely obscures the sight. Of these cataract and affections of the cornea are the most common. Other causes of loss of sight are to be found in diseased conditions of the nerve-supply of the retina, of the optic nerve, or of the lobes of the brain which deal with sight. Partial or total blindness, either temporary or permanent, may occur as a symptom of many general diseases, such as nephritis and diabetes; and of certain brain diseases, such as cerebral tumours; whilst hysteria and migraine commonly have ocular symptoms. Sight may also be injured or destroyed by injuries to the eye which appear comparatively trivial. Many drugs, such as opium, tobacco, quinine, alcohol, and others may cause irregularities of sight. *Tobacco blindness* is, in fact, comparatively common in slight degrees, and occasionally proceeds quite suddenly to complete blindness. The cure is the obvious one of discontinuing the use of tobacco. The results are often sensational, in the rapidity and completeness with which the sight returns to normal.

Colour Blindness. The condition known as colour blindness, in which an individual can distinguish the shape and size of objects normally, but does not perceive the usual range of colours, is a congenital and, usually, a hereditary one. It is thought to be due to some defect of the retina, and so far no cure for it is known. In different persons it is present in different forms, but the commonest defect is in the perception of red and green, which may be confused with each other. As these

are the colours universally adopted in juxtaposition for warning purposes, it will be seen that colour blindness may constitute a serious disability. Several occupations, such as engine-driving, flying, etc., are barred to the colour-blind for obvious reasons.

Amaurosis and Amblyopia. Amaurosis is a rather indefinite term used to designate cases of blindness in which no signs of disease can be found to account for the blindness. With the discovery of the ophthalmoscope, and with improvement in the methods of diagnosis of eye diseases, far fewer cases of bad sight go undiagnosed, and therefore far fewer cases are written off as amaurosis. Amblyopia is another indefinite term, used for lesser degrees of amaurosis. A typical case of amblyopia is the impairment of sight found in hysteria where there is no change in the structure of the apparatus of sight.

Dimness of sight resulting from disease elsewhere in the system than in the eye, such as kidney disease, or poisoning by tobacco and other drugs, constitutes amaurosis. Its treatment must be directed to removing or alleviating the underlying cause. Spectacles are not of much use, and will have no curative value.

THE REACTIONS OF THE PUPIL.

The pupil in the normal eye reacts in a definite manner to light. In a bright light it becomes small, and in a dim light it increases in size to enable more light to enter the eye. Normally, also, the two pupils react similarly to the same stimulus. Strong emotions and certain drugs also cause the pupils to dilate or contract, and the state of the pupils is a very valuable help to diagnosis in various diseases. Some people normally have pupils of different sizes, a condition which is known as anisochoria, but this again may be a symptom of some local injury or one-sided blindness, or be due to some general disease in the system such as an aneurysm, dental disease, or disease of the nervous system, such as general paralysis or locomotor ataxia.

NYSTAGMUS.

Nystagmus, a condition in which the eyes are continually moving in a rhythmical fashion, from side to side, or up and down, or with a circular motion, is present in disease of the labyrinths or semicircular canals which control the balance of the body. Sometimes it is due to disease of the eyes or of the parts of the nervous system which are connected with them.

THE ARGYLL ROBERTSON PUPIL.

The Argyll Robertson pupil, called after the Edinburgh physician who first described it, is the name given to the condition in which the pupils do not react to light.

DIPLOPIA.

This is the name given to double vision, an optical abnormality in which two images of the same object are seen. If the diplopia concerns one eye only it may be the result of some abnormality of refraction in the eye concerned, but if it disappears when either eye is closed, thus showing that both eyes are concerned in its production, it is true diplopia, and may be due to a transient weakness of the ocular muscles which will pass off. It may be the first warning of the disorder called disseminated sclerosis, or of the rare condition known as myasthenia gravis. A case of diplopia should therefore receive expert attention. The so-called double vision found after alcoholic excesses, in attacks of migraine, after the taking of drugs, etc., is really only blurred and muddled vision.

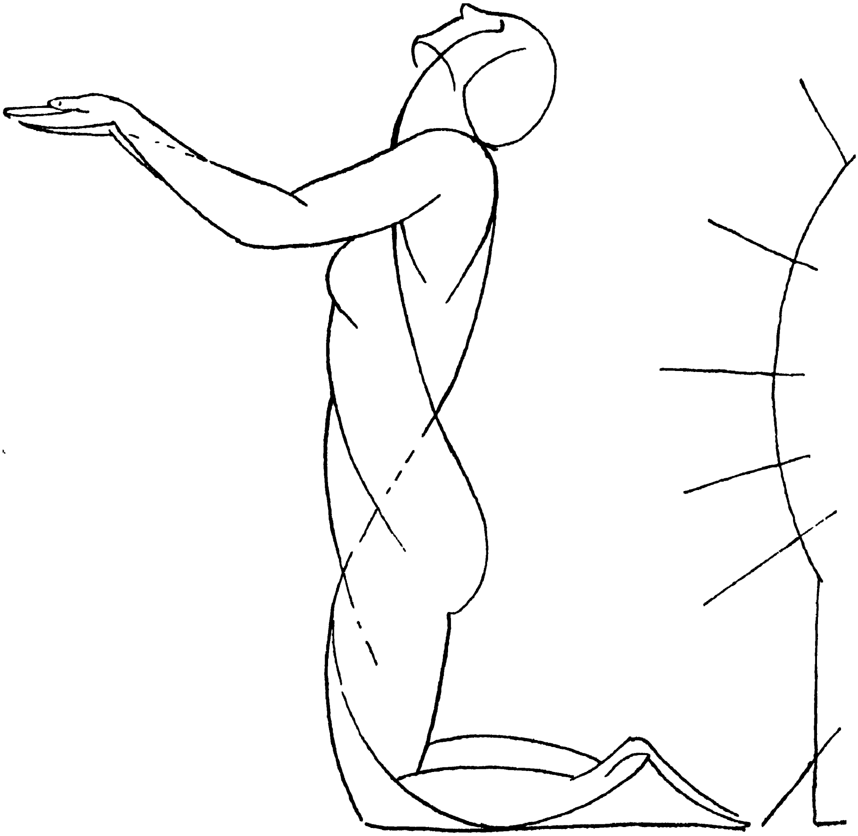
ERRORS IN SIGHT.

Asthenopia means simply weak sight, in such a case as where a person is not able to enjoy full use of his eyes because they wobble or become dim when he attempts to look fixedly at anything. Weak sight is due to such causes as errors in sight, short-sightedness or long-sightedness; muscular fatigue in the muscles controlling the eyes, such as is common after an illness; nervous disease or fatigue. The cause of the asthenopia must be discovered and treated accordingly, with the appropriate glasses if the sight is at fault, or suitable medical treatment and rest if the weak sight is due to a general cause. Over-indulgence in alcohol, tobacco, tea, or coffee should be guarded against, and the use of one of these may have to be cut out for a while.

Astigmatism. This is a very common condition, in which there is eye-strain because the light rays are not being properly focused on to the retina of the eye. It is very rare to find an eye that is totally free from some degree of astigmatism, but slight degrees cause no inconvenience, and are not recognized until some extra strain on the eyes, such as reading for an examination, attracts the individual's attention to the error. Astigmatism is remedied by suitable glasses.

Myopia. Myopia is simply short-sightedness. Near-by objects are seen clearly and easily, but objects at a greater distance are blurred. Spectacles for distance-seeing and reading are required to help out the vision. The opposite of myopia is long-sightedness, the characteristic being that objects in the near distance are blurred and that a distance greater than usual is easily visualized. Here again glasses for close work are indicated.

Squint. The technical name for squint is strabismus. In early childhood squinting is quite common, and is taken to show that the control of the brain over the eyes is not fully developed. As with walking, a child requires time and practice to develop the binocular vision which



THE SPINE AS AXIS
Concave curve

is universal and normal in later life, and in some children whose control over their eyes is weak any fatigue will cause them to relax and squint. From the aesthetic point of view, a squint is no enhancer of beauty, and from a practical point of view it becomes more and more dangerous to go through life with eyesight that cannot be relied upon to behave in a normal fashion, so it is of great importance to train the small child out of its squint, and in later life to correct a squint which appears as a concomitant of some injury or illness. Suitable spectacles, eye exercises, and in some cases operation, are the methods of treatment. General toning up of the system will increase the efficiency of the other measures.

WOUNDS AND FOREIGN BODIES.

As was said in the description of the structure of the eye, any irritation to the eye causes such intense pain to the individual that he usually seeks to remove the cause at once. This is one of Nature's ways of safeguarding sight, which is among man's most precious possessions. *Every injury to the eye should receive immediate attention.* Careful treatment of injury or inflammation in the early stages may avoid loss of sight in the damaged eye, and it must never be forgotten that undue strain thrown on the other eye may lead to blindness in it as well. The most frequent accident to the eye is undoubtedly the entrance of a foreign body; and the smallest particle of dust, splintered wood or metal, or coal, or road grit may be sufficient to cause grave damage. When a particle falls on it, the eye will water and thus the article may be washed to the corner of the eye, where it can be removed. Never rub the eye which has grit in it, but blow the nose and the particle may be dislodged so that it can be removed with the corner of a clean rag or handkerchief. If the foreign body be wedged under the upper lid, a few drops of a bland oil, such as castor oil, may be dropped into the eye in the hope that the particle will float out. If this is unsuccessful, gently grasp the rim of the lid and pull it out and downwards, pushing up the lower lid under it. Drop the upper lid, and as the lids slide apart again, the particle is very often carried out on the lashes of the lower lid. If these first-aid measures are unsuccessful, no further attempt should be made, but the patient should be taken at once to the doctor. In the case of larger particles which are apt to enter the eyes of workers in such places as steel works, expert advice should be obtained at once.

Wounds of the Eye. Any sort of wound may happen to the eye, and accidents in which rods of metal or wood, such as prongs of pitch-forks, tools of all sorts, projecting parts of cars or furniture, stones, golf-balls, elbows and fingers at football, etc., enter the eye and lacerate it are fairly frequent. First-aid treatment only should be attempted, and the patient should as soon as possible be taken to the doctor, or the doctor

be sent for if there is collapse from the shock and pain, which is often severe. The eye may be covered with a pad of wet boracic lint, and bound up with a bandage. Hot tea or coffee or other stimulant may be given to restore the patient. The worst aspect of an eye accident is the frequency with which the other, sound, eye becomes involved, and loses its sight, even though the damaged eye may recover.

Black Eye. Black eyes, in which the tissues round the eye become suffused with blood and discoloured, are common. The usual cause is a bruise in the region of the eye caused by a blow or knock, but sometimes black eyes occur after such happenings as operations on the nose. In a few days the blood which has collected in the tissues will be absorbed, and the dark colour will fade through shades of yellow to a normal colour again. Immediately after a blow has been struck on the eye, cold wet cloths should be applied, or the part should be covered with pads of cotton-wool soaked in weak lead lotion. This treatment if applied soon enough may prevent a black eye from forming, and is cheaper and more efficacious than the slab of raw beef-steak of popular tradition. If a black eye develops in spite of these precautions, hot compresses may be used to relieve any pain, and grease-paint during the day will conceal some of the disfigurement without doing any harm.

CONJUNCTIVITIS.

The conjunctiva is the lining of the eyelid, and the covering of the front of the eyeball. It is very subject to inflammation of varying degrees of severity. The chief symptoms are pain, smarting, itching, and watering of the eye or the exudation of sticky or purulent material, which may be so severe as to gum the lids together in the mornings so that they have to be soaked apart with warm lotion before the eye can be opened. The blood-vessels in the white of the eye may be red and engorged. There are many causes of conjunctivitis: general debility from whatever cause, or eye-strain due to defects or over-work of the eyes; irritation from any cause, such as smoky atmosphere or exposure to dust or too bright light. Many of the infectious diseases, such as measles and diphtheria, have eye complications.

The treatment of conjunctivitis should never be neglected. The cause of the condition where known should be remedied, and rest provided for the eyes, either by a period of comparative disuse or by glasses. Protection from smoky rooms, dust, glare, cold winds, etc., can be obtained nowadays by the use of the appropriate goggles or coloured spectacles. The eyes should be bathed by means of an eye-bath, several times a day, with some antiseptic lotion such as a weak solution of bicarbonate of soda or boracic acid. Yellow oxide of mercury ointment may be applied to the rims at night. The general health should be attended to, and precautions should be taken not to

infect other members of the household. Special towels and washing materials should be kept to scrupulously.

PINK-EYE.

Pink-eye is the name given to a very infectious form of catarrhal conjunctivitis which is found at intervals in schools and other institutions. It must be regarded and treated as other epidemics of infectious diseases. The outbreak usually dies down in a couple of weeks.

TRACHOMA.

This is a form of conjunctivitis in which small granular nodules form under the conjunctiva. It is very infectious and very chronic, and the peasant races of middle and eastern Europe are heavily infected with it. So much is this the case that emigrants seeking to enter the United States are excluded if they show signs of infection. The results of trachoma are often very disastrous. The sight may be seriously damaged, and the eyelids may become deformed.

OPHTHALMIA NEONATORUM.

This form of sore eyes of early infancy, which may lead to lifelong blindness, is due to a suppurative conjunctivitis, caused in the great majority of cases by gonorrhoeal infection. Unless treatment is prompt and thorough the child may lose its sight. Because of the great danger of this disease it has become routine treatment for the eyes of newly born babies to be bathed with antiseptics immediately after birth, even where there is no suspicion of infection.

ULCERATION OF THE CORNEA.

The covering membrane of the eyeball, called the cornea, is subject to ulceration of various kinds. Even such a small wound as a tiny scratch may lead to inflammation and ulceration. Children from poor and dirty homes often develop these ulcers, sometimes in conjunction with tuberculous glands in the neck. Older people in poor health are prone to corneal ulcerations. When inflammation is present in the cornea without actual ulceration, the condition is called keratitis. All corneal inflammations require expert advice and treatment.

CATARACT.

As was said in the description of the working of the eye, the lens of the eye is normally transparent and crystalline. Clear sight depends upon this transparency being maintained. In the condition known as cataract, the lens of the eye becomes gradually thickened and opaque, and loses its transparency, so that the light comes through only dimly. The condition is a fairly common one in elderly persons. There are no symptoms noticeable by the patient, except increasing dimness of

the sight, but examination by the oculist reveals other characteristic features. No treatment will cure cataract except operation, which can only be performed when the cataract reaches a certain stage of development. In the meantime a preliminary treatment, in which atropine drops are employed, is sometimes palliative. This can only be used under constant supervision, lest the serious condition of glaucoma should develop.

The process of 'ripening of the cataract,' as it is called, takes a considerable time, sometimes two to three years. When the oculist decides that the right time has come, he will perform the requisite operation. The after-treatment is simple but important, and a good recovery will depend largely upon the care taken of the patient at this time. Some surgeons insist on complete darkness after the operation, but this treatment sometimes has a very bad effect on the mental condition of the patient, who begins to despair of ever seeing again; and it is more popular nowadays to have fewer dressings, and allow a moderate degree of light. In some cases the patient even begins to use the eye for short periods within a couple of hours of the operation. All patients must rest in bed, however, for three or four days, and quiet is essential.

GLAUCOMA.

In the eye disease known as glaucoma the special characteristic is an increase in pressure within the eye. The name is taken from the Greek word meaning 'sea-green,' because in many cases the pupil becomes greenish in appearance. It is most common in elderly persons of either sex, and has been known in a good number of cases to follow a period of great mental stress or strong emotion. An attack of glaucoma usually begins during the night, when the patient wakens with severe pains of a neuralgic character in the eye and side of the head. There may also be sickness. It is unfortunate if the individual passes the attack off as a migraine or sick headache, because glaucoma can entirely destroy the sight of an eye in a day. Usually, however, the case is more chronic, and goes on for a week, or even a month, before things are beyond repair. Glaucoma is a serious disease as regards the sight, and the sooner treatment is begun the better the chances of preserving the sight. It used to be regarded as an incurable disease, but nowadays treatment by operation gives good results. If, for any reason, it is considered inadvisable to operate, drops of a substance called eserine may be used for an indefinite period to contract the pupil and alleviate the condition.

BLEPHARITIS OR SORE EYELIDS.

Sore eyelids are very common. They occur in persons, of any age, who are run down, but are most common in delicate children. Catarrhal

conditions of the nose, eye, or ear, chronic skin diseases, anaemia, rickets, malnutrition, and infective and debilitated states of health generally may cause the eyelids to become sore and inflamed. Uncorrected errors of sight, and exposure to dust, glaring lights, etc., are also frequent causes. The condition is apt to become very chronic, and treatment may have to be carried out for months before a cure is achieved. Even then a return of the original debility may cause the lids to redden again. Any cause of ill-health must be attended to, and the general tone of the body raised as much as possible, by good food, rest, fresh air, and correct hygiene. Tonics such as those containing iron, arsenic, and strychnine are very useful, and a course of cod-liver oil often helps. The local treatment is to bathe the eyes several times a day in a warm mild antiseptic, such as a weak solution of boracic acid or bicarbonate of soda. At night, yellow oxide of mercury ointment may be rubbed into the edges of the lids, and in severe cases the doctor may paint the eyelids with a silver preparation, such as argyrol or protargol. Chronic inflammation of the eyelids can be very disfiguring, and may lead to damaging of the eyelids and falling out of the eyelashes. At one time the lashes used to be removed, but this blemishing operation is fortunately no longer carried out.

BLEPHAROSPASM OR TWITCHING EYELIDS.

Twitching or fluttering of the eyelids is another common accompaniment of weak eyesight, especially if supplemented by physical or mental debility. The treatment aims at toning up the general condition, and correcting any errors of sight.

STYE OR HORDEOLUM.

A very common and painful boil, which starts in the root of an eyelash, is known as a stye. Styes arise at any age and in either sex, at any time, and they may appear singly or in crops. They often accompany a poor state of health. The treatment is the same as for inflammation of the eyelids.

THE EAR

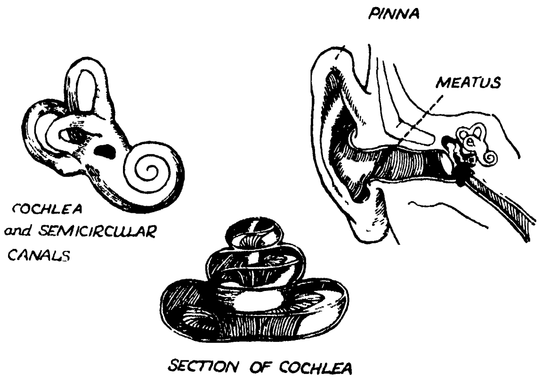
The process of hearing is a very complicated one, so it is not surprising that the ear should be a very complex piece of mechanism, especially when it is remembered that as well as being concerned with hearing, it is also largely responsible for maintaining the balance of the body. The structure of the ear is most easily understood by considering it in three parts: the external ear, the middle ear, and the internal ear. These are described in an earlier part of this book. Here are summarized some of the principal features.

THE EXTERNAL EAR.

The external ear includes the outer flap, or pinna, and the tube which leads up to the ear drum, called the external auditory meatus. The function of the different parts of the external ear is to collect sounds, and direct them to the ear drum. In animals the pinna can be 'flapped' in various directions for the purpose of locating and picking up sound more easily, but civilized man has lost this power, or loses it in childhood, since babies can often wriggle their ears in a fashion impossible to most of us when we grow up.

THE EAR DRUM AND MIDDLE EAR.

The function of the middle ear is to receive the sounds collected by the external ear, and pass them on to the inner ear. It comprises the drum or tympanic membrane, which is only three-thousandths of an



DIAGRAMS OF EAR

inch thick, and the tympanic cavity, which contains the three small bones or ossicles of the ear and two tiny muscles attached to them. From the middle ear the Eustachian tube leads to the throat. This tube brings air up to the inner side of the ear drum so as to maintain equal pressure on both sides of it; it also allows secretions from the ear cavity to drain down to the throat. The cells of the mastoid process are also included within the ambit of the middle ear. The outermost part of the middle ear is the ear drum, whilst a thin layer of bone divides the roof of the middle ear from the brain. Thus it is that disease may easily spread from the ear to the brain.

THE INTERNAL EAR.

It is in the internal ear that the master parts of the organ of hearing are to be found. It is set within little bony tubes and hollows, to which

is given the appropriate name of the bony labyrinth, deep in the hardest part of the temporal bone. Inside the bony labyrinth is a membranous labyrinth of much smaller calibre, and the space between them is occupied by a fluid called the perilymph. The membranous labyrinth contains another and similar fluid called the endolymph. The organ of Corti, the essential organ of hearing, is contained within a part of this labyrinth which is coiled like the shell of a snail and thus gains the name of the cochlea. The other portion of the labyrinth consists of three mesicircular canals, each containing a tiny nervous structure; these semicircular canals control the sense of balance.

THE WORKING OF THE EAR.

When a sound impinges upon the ear drum it sets it vibrating; the vibrations are then conducted across the middle ear to the internal ear. It is generally believed that the vibrations are conveyed by the chain of three ossicles, the malleus (hammer-shaped), incus (anvil-shaped), and the stapes (stirrup-shaped), the malleus being attached to the ear drum and the foot of the stapes to a vibrating membrane, known as the oval window, over the perilymph. These three bones move together, and when the malleus is pushed in by the vibrating drum, the stapes pushes in the membrane covering part of the perilymph, setting up waves in it. As the foot of the stapes, however, is held more firmly above than below, the movement is of a somewhat rocking nature, and the waves of the perilymph are not so violent as the vibrations of the drum.

Some authorities, however, suggest that sound vibrations would never travel by a chain of bones when they could more easily be transmitted by the air in the middle ear; in their opinion the vibrating drum sets up corresponding vibrations in the air in the tympanic cavity, and this sets in motion another membrane covering part of the perilymph, called the round window, which is quite separate from the oval window to which the foot of the stapes is attached. These authorities believe that the chain of ossicles has partly a protective influence, so that, when any very loud noise occurs, these ossicles 'damp' it down by their movements, and also change the tension in the perilymph for different sounds, adapting it to an optimum pressure. It is difficult to say which of these opinions is correct, but it is more likely that the round window is a safety valve, bulging outwards when the oval window's membrane is pressed in, than that it is a vibrating transmitter of sounds. To the malleus, and also to the stapes, are attached tiny muscles, the former called the tensor tympani, and the latter the stapedius; in human beings these muscles have apparently very little, if any, function, but in other animals it has been shown that loud sounds cause these muscles to contract, and that they have probably a protective influence, such as some investigators have attributed to the whole chain of ossicles.

When a sound reaches the internal ear (whether by the oval window or by the round window does not really matter) the perilymph is set in motion. These vibrations are transmitted through the thin walls of the membranous labyrinth to the endolymph within it, and so to the cochlea. This little tube has a partition—the basilar membrane—which divides it into upper and lower galleries, except at the tip where there is a small opening between them. The basilar membrane is formed by hundreds of transverse fibres, which increase in length towards the top of the coiled shell, where they are held by a ligament which is strong at the base of the shell and almost non-existent at the apex. This formation of the basilar membrane has led some authorities to believe that it vibrates like a stringed musical instrument when sound vibrations are conveyed to it by the endolymph, and that each fibre vibrates in sympathy with a particular tone, these vibrations being then sent on to the brain, which interprets them. On the upper surface of the basilar membrane is placed the organ of Corti, a delicate and elaborate structure, named after the Italian nobleman to whose anatomical researches its discovery is due. This microscopic organ consists of a double row of rods which slant towards each other so as to meet at their upper ends. Internal and external to these supporting rods are cells, from the outer ends of which come a number of hair-like processes. These hairs are in contact with the tectorial membrane, a roof-like gelatinous structure overhanging them, which is anchored at its inner end and free at its outer. As the basilar membrane vibrates, the hairlets of the hair cells are pressed backwards and forwards along the under surface of the tectorial membrane, so that very delicate gradations of the vibrations of the basilar membrane can be appreciated. According to the supporters of this theory of the mechanism of hearing the fibres of the basilar membrane do not vibrate separately, but the whole membrane vibrates as one structure, and the analysis of the sound takes place entirely in the brain. Opinion is still divided, but most scientists incline to the theory that the analysis of sound takes place in the cochlea by the vibrating of the different fibres. This theory is associated with the name of Helmholtz.

THE ACOUSTIC NERVE.

From the organ of hearing in the cochlea fine nerve-fibres are collected through the passage in the temporal bone called the internal auditory meatus, to form the acoustic nerve, along with other nerve-fibres from the balancing part of the internal ear. The nerve-fibres from the organ of hearing go into the substance of the brain, and pass to the superior temporal convolution on the surface of the brain, where the hearing centre is situated.

Disorders of the Ear

DEAFNESS.

The most common affection of the ear is deafness, which is of various types; and unfortunately the most common types of deafness are among the most difficult to cure. An impacted plug of cerumen or wax in the external meatus will cause deafness and should be removed by syringing. This must be carried out with care, as careless syringing can do much damage, and has even been known to cause acute inflammation of the ear, and so on to inflammation of the mastoid cells. It is best to drop a few drops of hydrogen peroxide or liquid paraffin into the ear for two or three nights before syringing, in order to soften the wax. The person whose ear is to be syringed should be seated, with a towel fastened round the neck, and he should hold a kidney-shaped receiver or a large basin close against his jaw, under the ear, to catch the lotion returning from the ear. The person syringing should pull the external ear backwards and slightly upwards to straighten the passage, which is normally curved. The best lotion to use for syringing the ear is a bicarbonate of soda solution (two teaspoonfuls to a pint of warm water). The water should not be hot, but warm, at about 100° F. Before using the syringe (a metal syringe is best, but a glass syringe or one of the Higginson pattern may be employed) it should be pointed upwards, and the plunger pushed in until the lotion begins to run out. The lotion should be syringed along the roof of the passage of the ear (external auditory meatus), and should return along its floor, bringing the wax with it. After examining the ear to make sure that all the wax is out it should be dried carefully with cotton-wool. If the wax does not come out after six syringefuls, it is safer to wait for another two or three days, using the drops to soften the wax as before.

Furuncle. Deafness may also be caused by a furuncle or boil in the ear; but the diagnosis of this must be made by a doctor, as it may be confused with other and more serious conditions, such as mastoid inflammation. When the boil is dispersed or opened, the deafness from this cause disappears.

Middle Ear Deafness. By far the greater number of cases of deafness, however, are caused by affections of the middle ear. Catarrh of the middle ear or of the Eustachian tube is always due to an extension of a catarrhal affection of the nose or throat up the Eustachian tube to the ear; the lining membrane becomes congested, and pours out an abnormal amount of the rather sticky fluid which it normally secretes. Frequently, with the help of inhalations of steam from hot water, in which friar's balsam or menthol is dissolved, and of aspirin or something similar taken internally, this catarrh clears up in a few days; but sometimes the Eustachian tube has to be cleared by blowing through

it with the aid of an air-bag (Politzer's bag), which requires the skilled hands of a doctor, or even by having the ear drum slit with a tiny knife, under gas or other anaesthetic, in order to let the mucus out from behind the drum. Whatever method may have to be employed, it is important to have proper treatment at an early stage, or the trouble may progress to chronic catarrh of the middle ear, which is the most common cause of deafness, and is very difficult to cure. The name, chronic catarrh of the middle ear, gives a fairly good description of the condition present, but it has been pointed out that at the chronic stage the middle ear is the site of a chronic adhesive process or a diffuse fibrosis rather than of a catarrh, though a catarrh is the preliminary stage. When the catarrh persists, the lining membrane of the middle-ear cavity remains swollen and impedes the vibrations of the drum and the movements of the ossicles, so that the sound waves do not pass clearly through to the internal ear. Gradually the swollen lining membrane becomes transformed into new connective tissue, which forms adhesions between the ossicles and the walls of the tympanic cavity, and causes the foot of the stapes to become fixed by fibrous attachments. The Eustachian tube may itself become narrowed or blocked by a fibrous stricture. This description explains why it is so difficult to improve deafness due to chronic catarrh of the middle ear, though sometimes regular inflation through the Eustachian tube improves it in the earlier stages, whilst dilatation of the tube by a bougie may improve the deafness when it is due to Eustachian blocking rather than to middle-ear fibrosis. It is very important, therefore, by preventing or curing adenoids, diseased tonsils, an obstructing septum in the nose, or disease of the nasal sinuses, to try to prevent the occurrence of catarrh in the Eustachian tube or middle-ear cavity by keeping the nose and throat in a healthy condition. Nasal douches are not to be recommended for this purpose, as they tend to keep up the swelling of the mucous membrane, and may even get up into the Eustachian tube and help to block it; simple nasal drops of liquid paraffin containing menthol (five grains to the ounce), and eucalyptol or cajuput oil (two or three drops to the ounce), trickled down both sides of the nose, are far preferable to nasal douches.

Adenoids are a common cause of catarrh of the middle ear in children. It is possible that some day a method will be discovered of preventing adenoids, or of curing them without operation; but up to the present, whether it be due to the climate, or to diet, or some other cause, they continue to be very common; and no method of curing them once they have become established has yet been discovered except by an operation, which is, however, fortunately only a minor one.

Otosclerosis. This is another cause of middle-ear deafness, but it is not brought about by catarrh. The deafness of otosclerosis is due to obscure changes in the bony labyrinth, and especially by bony fixation

of the foot of the stapes. It is a disease of peculiar interest, and peculiar reproach, to otologists, for neither its cause nor its cure is known, although it is not at all uncommon, especially among young women. It may be allied to the bone disease called osteitis deformans, or it may be due to calcium metabolism disturbance, or to congestion of the blood-supply to the area affected; but, in spite of much research work, nobody yet knows.

OTITIS MEDIA.

Inflammation of the middle ear or otitis media may arise from an attack of acute catarrh or from some other infection from the nose or throat; it always comes from the nose or throat, and it is useless to put cotton-wool in the external passage of the ear to prevent cold from inflaming the middle ear. In the early stages the installation of a few drops of dilute carbolic acid in glycerine (4 or 5%), warmed, will ease the pain; dry heat, such as that of a hot-water bottle, will also help, but fomentations or poultices should not be used. If the inflammation goes on getting worse, the ear drum will have to be slit, under an anaesthetic, to let out the pus from the middle ear. This operation, which is known as a paracentesis, is simple if performed by an expert, and the incision in the drum will soon heal up. No one need be afraid that it will cause deafness afterwards—in fact, it will prevent deafness, by letting out the pus before it has time to damage the structures in the middle ear.

EAR-ACHE.

This is most commonly due to inflammation in the middle ear, behind the drum, but it may also be caused by a boil in the outer ear passage, by wax against the drum, by a pea or other foreign body in the ear passage, by a sore throat or toothache (the pain travels up to the ear easily), or by a variety of other causes. Unless, therefore, an ear-ache subsides within twenty-four hours, a doctor should always be called in to diagnose the cause and carry out appropriate treatment.

OTORRHOEA.

Chronic suppuration of the middle ear, sometimes called otorrhoea, is due to neglect or inadequate treatment of an acute inflammation. A discharging ear which does not clear up in a few days should always be seen by a doctor, for not only is any chronic discharge bad for the health, but a chronic discharge from the ear will in time cause deafness, and may even give rise to an abscess in the brain, which is only separated from the ear by a thin plate of bone. Peroxide of hydrogen has been for long the favourite prescription for ear-drops in the treatment of a discharging ear; many doctors advise against its use nowadays, on the ground that when it bubbles the infection may be carried more deeply

in, but it is a useful cleansing application when there is a lot of debris deep in the ear. It may be followed or accompanied by boracic acid in spirit (ten grains, or more, to the ounce). The more up-to-date method of treatment is not to use drops or douching at all, but to mop out the discharge with cotton-wool and then blow in a powder containing iodine 1 % in boracic powder, once or twice a day. This method has been known to clear up ear discharges of several years' standing. Ears, however, should never be allowed to go on discharging as long as that, although it is surprising how many people go on putting up with a discharging ear in the belief that nothing can be done for it. Sometimes removal of adenoids or septic tonsils is enough to clear up a discharge, but occasionally the operation of draining through the mastoid process is necessary; people are unnecessarily afraid of the word 'mastoid,' for the modern simple mastoid operation is not a very serious one, causes the patient very little, if indeed any, pain, and is healed in ten days. The radical mastoid operation is more serious, but it is not performed so frequently as it was a few years ago, and only for old chronic discharges, which other methods have failed to cure.

NERVE DEAFNESS.

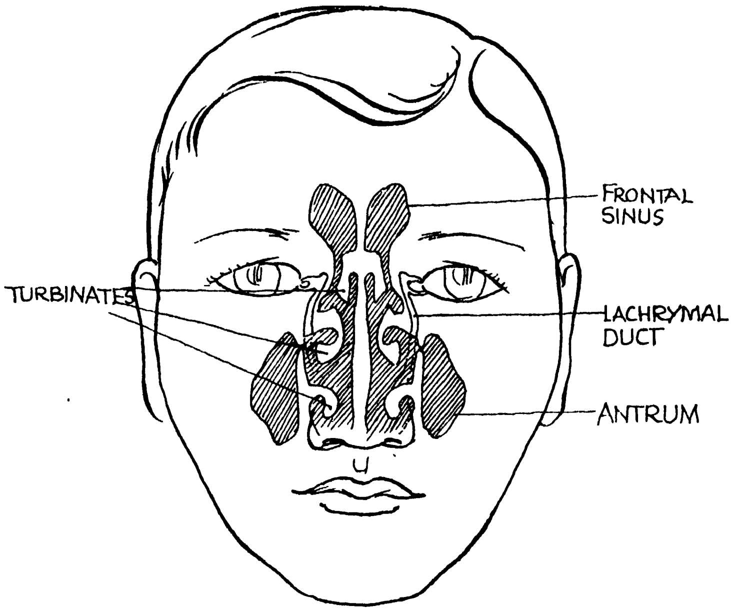
This is due to an affection of the cochlea or of the acoustic nerve. Boilermaker's deafness is of the nerve deafness type, and is due to the effect on the internal ear of the continual noise. Syphilis, meningitis, mumps, and various drugs may affect the acoustic nerve, causing nerve deafness; such drugs include quinine, arsenic, and tobacco, all of course when used in large amounts.

ARTIFICIAL AIDS TO HEARING.

Not all types of deafness respond to artificial aids, and no one should buy an acoustic appliance without first having the ears examined by a doctor—cases have been known of persons with merely wax in the ears using artificial aids; nor should these be used for deafness due to an active ear discharge. Non-electrical appliances of the ear-trumpet type are less expensive, less troublesome to maintain, and often quite as effective as electrical aids, but they are, of course, more conspicuous and more cumbersome. The ordinary electrical instruments have themselves a restricted hearing range, and are usually most suitable to older persons who cannot hear the conversational voice of an acquaintance seated about three feet away. Young people should not be encouraged to use electrical or non-electrical appliances, but should be taught lip-reading, which is the best artificial aid to hearing. It should be remembered that any artificial aid is only a crutch to the hearing, and that its use will not improve deafness.

The Nose

The nose is a much more important organ than many people think, for its function of smell belongs to only a very small area in it, its real importance lying in the fact that it is the entrance to the lungs. The nose is adapted to warm and slightly moisten the entering air on its way to the lungs, by having little long cushions projecting into the nasal passage on each side; these cushions are the turbinals or turbinate bones,



and they make the air travel to the upper part of the nose when it is breathed in, and along the lower part of the nose when it is breathed out. Connected with the nose are cavities in the bones of the face, called the nasal sinuses. The largest of these sinuses are the maxillary antra, one antrum being situated within each upper jaw; the frontal bone has also a large air sinus on each side, called the frontal sinus, over the eye; and the ethnoid and sphenoid bones, which form part of the base of the skull, also have nasal sinuses within them.

All these sinuses are filled with air, which comes from the nasal passages, and any infection of the nose may easily get into them, and may be very difficult to get clear again without a drainage operation. Infection of one or other, or of several, of the nasal sinuses may be the cause of serious ill-health, which may go on for years without its true cause being suspected. It usually requires an X-ray examination to

make the diagnosis of nasal sinus disease certain. Animal feeding experiments have given rise to the suspicion that some infections of the nasal sinuses may be due to an ill-balanced diet, when the anti-infective vitamin is deficient.

So-called *nasal catarrh* is a common affection of the nasal passages, and it is a popular fallacy that it is incurable; it is incurable only when its cause has not been recognized, for the cause may be infection of one of the nasal sinuses, or even unhealthy tonsils. Nasal douching with an alkaline or mildly antiseptic solution is a usual, but frequently ineffective, method of treatment; it is usually better practice to use simple nasal drops, containing menthol and eucalyptol or cajuput oil, or ephedrine in liquid paraffin, holding the head very far back when the drops are trickled into the nose.

Nose-bleeding is nearly always due to the breaking of a dilated blood-vessel in the front part of the dividing partition of the nose. The best way to stop the bleeding is to press the outer side of the nostril firmly against the partition. Packing the nose with cotton-wool may have to be resorted to, but it requires a doctor to do it properly. Nose-bleeding may be a symptom of various diseases, and so should not be taken too lightly; though the ordinary bleeding from a dilated blood-vessel need not cause any alarm, as it can nearly always be controlled by the simple means described.

The Pharynx

The pharynx is that part of the throat which lies beyond the mouth, extending upwards to the back of the nasal passages, and downwards to the beginning of the larynx and the gullet. On each side of the pharynx are the faucial tonsils, which are almond-shaped masses of lymphoid tissue (the tissue of which lymph glands are formed) about an inch in length and half an inch in depth. There are other smaller masses of lymphoid tissue in the same region, especially Lushka's tonsil, in the post-nasal space, up behind the uvula, to which, when enlarged, is given the name of adenoids; and the lingual tonsil, the name given to the lymphoid tissue in the back of the tongue, which is sometimes enlarged and irritable, especially in adults who have had their faucial tonsils removed. This whole arrangement of lymphoid tissue masses is called Wildeyer's ring, and it is supposed to have a protective function, which is more active in early life. Various other functions have been suggested for the tonsils, and an extract has even been prepared from them for use in various disease conditions; but it is doubtful if they have any function other than that of the ordinary lymph glands. But the tonsils, while serving as a bulwark against disease when healthy,

can also be a menace when they are themselves diseased. A list of the diseases that have in the past been attributed to infection of the tonsils would read like the index of a textbook of medicine, but there is a reaction against the wholesale removal of tonsils and adenoids in children that was prevalent a few years ago. Nevertheless, it is true that unhealthy tonsils can cause a good deal of ill-health; and when a child loses its appetite, is flat-chested, and has enlarged glands of the neck, unhealthy tonsils may be suspected. In an adult, persistent rheumatism or neuritis, or even dyspepsia, may be due to unhealthy tonsils. Up to the present no effective remedy has been devised for unhealthy tonsils except their removal, which is, fortunately, not a very difficult matter, even in an adult.

METHOD OF HOLDING A CHILD FOR EXAMINATION OF THE NOSE AND THROAT

Adenoids are found in children and, very rarely, in adults. As adenoids cause mouth-breathing and have a definitely bad effect on a child's health, and may set up inflammation in the ear, they should be removed whenever discovered; breathing exercises should be carried out after their removal, but no breathing exercises of themselves will cure adenoids, nor will thyroid extract or any other medicinal remedies. It is said that adenoids may be due to improper feeding, but it is more likely that they are caused by an infection persisting in the post-nasal space.

Pharyngitis is usually due to infection or inflammation of the tonsils, and is best treated by the application of Mandl's paint, which contains iodine in glycerine, flavoured with peppermint.

Quinsy is the name given to an abscess of the tonsil, which may be very painful, and cause difficulty in swallowing; this abscess requires to be opened by a doctor, although hot fomentations or antiphlogistine applications will help in the early stages.

Tonsillitis. A case of inflammation of the tonsils should always be examined by a doctor, for an apparently mild form of tonsillitis, with but a slight rise of temperature, may sometimes turn out to be diphtheria.

The Larynx

The larynx is the essential organ of voice-production, although the sounds produced by it are modified by the tongue, the teeth, and the lips, and its resonance by the nose and the hollow sinuses connected with

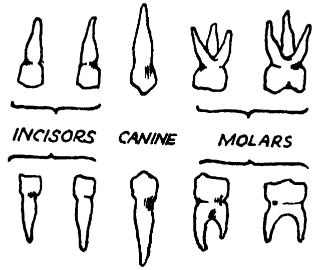
it. The larynx causes the projection in the neck, known as Adam's apple, and forms the upper part of the air passage from the lungs; it is said by some writers that the primary function of the larynx was protective, as the vocal cords can prevent the entry of air or water into the lungs, and that the function of voice-production is a much later development. The larynx consists of a large winged thyroid cartilage, above the ring-shaped cricoid cartilage, two tiny arytenoid cartilages (with two pairs of even smaller subsidiary cartilages), which are placed on the edge of the cricoid, and the cartilage of the epiglottis, which projects over the entrance of the larynx and protects it. These cartilages are bound together and to the neighbouring structures by ligaments and muscles. Within the larynx are a set of small muscles, the chief function of which is to move the vocal cords; these are not really cords, although they look like them when the larynx is examined with the help of a mirror, but are the edges of sharp folds of tissue sticking out into the larynx. Their movements are controlled by a pair of nerves, called the recurrent laryngeal nerves, because they turn back from the important vagus nerve to supply the motor-control of the larynx. The vocal cords move together, to and fro, making a chink which is wider or less wide as they move, and the air from the bellows of the lungs passing through the chink between the vibrating vocal cords produces the sounds of the voice. Speech production is controlled by a definite part of the brain, in the region of the inferior frontal convolution—this part being situated only on the left side of the brain in right-handed persons, on the right side in left-handed individuals.

The most common disorder of the larynx is *laryngitis*, or inflammation of the larynx, which may cause slight or marked hoarseness, or complete loss of voice. The usual cause of laryngitis is the extension downwards from the nose or throat of a cold. It is best treated by rest in bed, inhalations of friar's balsam (a teaspoonful to a pint of hot water and the steam inhaled), cold or hot fomentations to the throat, and aspirin in small doses internally. *Chronic laryngitis* is manifested by persistent hoarseness, and demands examination of the larynx by a doctor who is accustomed to use a laryngoscope. Sometimes—though comparatively rarely—chronic laryngitis is due to tuberculosis or a growth, both of which must be treated in the early stages of the disease to effect a cure. More frequently, however, chronic laryngitis is due to forced use of the voice whilst the patient is suffering from catarrhal laryngitis, or to bad voice-production, especially in professional voice-users, such as school teachers, actors, and clergymen. The first essential in the treatment of chronic laryngitis is rest for the voice, and sometimes silence must be maintained for a prolonged period. A simple alkaline nasal douche, which clears a blocked nose, may be very

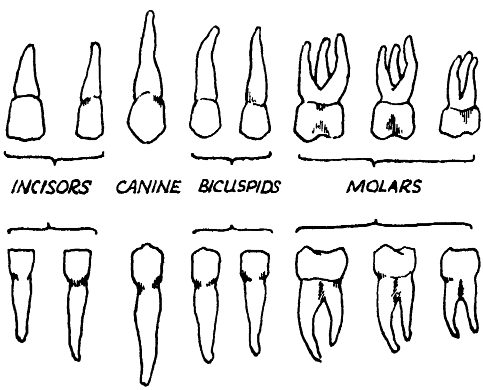
helpful in this condition, but application of oily or astringent preparations to the larynx may be necessary. This, however, requires the skilled hand of a throat surgeon.

The Teeth

As the development of the teeth starts at a very early age, actually before the child is born, it is most important that the mother should guard her health in order that her child may benefit later. We are supplied with two sets of teeth—the first called temporary or milk teeth, and the second called the permanent teeth. The milk teeth usually begin to make their appearance at about the age of six months. They are twenty in number, ten above and ten below, consisting of four incisors; two canines, popularly known as eye teeth; and four molars, in each jaw. They do not make their appearance above the gum all together, but are cut gradually and in definite groups. The first to appear are the lower central incisors, at the age of six months; then follow the upper central incisors about two months later, and these in turn are followed by the upper and lower lateral incisors. At the age of twelve months the first molars appear, then the canines in the eighteenth month, and the second molars in the twenty-fourth month. These times vary with each individual child, and in rickety and backward children may be very much delayed.



TEMPORARY OR MILK TEETH



PERMANENT TEETH

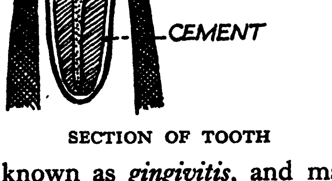
The teething period may be marked by symptoms of irritability, but in a perfectly healthy normal child it should not cause any serious disturbance of health. The gums may become inflamed and tender, causing the child to be feverish and restless, and the digestion is often disturbed, or there may be constipation or diarrhoea. A great deal of trouble may be avoided by taking precautions to see that the child's mouth is kept absolutely clean, and by the administration of the proper care

and food during the first six months of life. The habit of cleansing the mouth cannot be too early established—this is best carried out before teething by going gently over the mouth with a piece of cotton-wool dipped in sterilized (boiled) water or a saturated solution of boracic acid. Later, a very soft brush may be used, and by the age of three the child should be able to use it for itself, regularly twice a day. Owing to the structure of the first teeth, when decay sets in, they are rapidly destroyed; but, although they are only temporary teeth, it is advisable to preserve them as much as possible until they loosen and come out.

The permanent teeth generally begin to appear about the sixth year, and it is always a good thing for the parent to consult a dentist at this time to make sure that the positions of the teeth are going to be regular, as a little attention at the proper time may save needless pain and discomfort in later life. In an adult there are thirty-two teeth, each row consisting of four incisors in the centre with one canine on each side; then come two pre-molars next to the canines, with three molars on each side of them. The wisdom teeth are the last molars, and the time for their eruption varies considerably; they may appear between the seventeenth and the twenty-fourth year, but occasionally they do not appear at all. The normal time for cutting of the permanent teeth, apart from the third molars, or wisdom teeth, usually spreads over a period of six years. If the teeth are overcrowded, the dentist may advise the extraction of one or two to allow the others to develop in more regular positions.

AFFECTIONS OF THE TEETH AND GUMS.

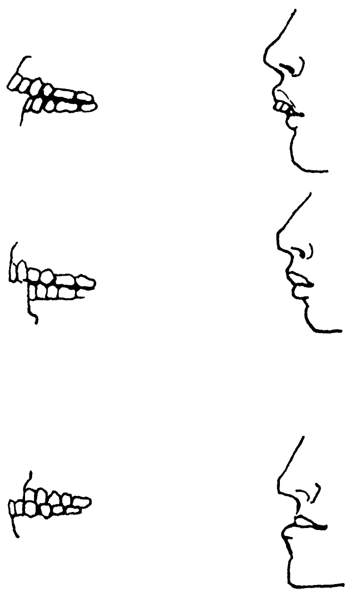
Diseases of the gums generally arise as a result of irritation, or of infection of the teeth. Ulcers may be caused by a badly fitting dental plate or by too vigorous brushing of the gums with a hard toothbrush. These can be quickly cleared up by the use of an antiseptic mouth-wash and by removal of the cause of irritation. Small sores very often form as a symptom of intestinal disturbance and, again, a good antiseptic mouth-wash should be used. Spongy gums, in which the gums become soft and inflamed, and bleed easily, may be caused by infection or by lack of cleanliness of the mouth. This condition is known as *gingivitis*, and massage of the gums along with a mouth-wash of hydrogen peroxide ought to clear matters up. In *ulcerative gingivitis*, which is due to an infection, the gums become very inflamed



SECTION OF TOOTH

and swollen, and the pain may cause the patient a great deal of discomfort. In every case of ulcerative gingivitis it is advisable to call in a doctor, as special treatment is usually necessary.

Pyorrhoea is a disease of the gums which takes the form of a chronic inflammation around the neck of a tooth, accompanied by a discharge of pus. The gum gradually recedes from the tooth, exposing the root, loosening the tooth, and causing considerable pain. Although the disease may attack one tooth only, it generally tends to spread to the neighbouring teeth. Needless to say it is more an affection of later life than of the young, and the dangers which may result from the continuous discharge of pus from the sockets of the infected teeth are very grave indeed. The gradual absorption of poisons into the blood-stream tends to undermine the general health, and it is sometimes necessary to have all the teeth removed.



EFFECT ON EXPRESSION OF DEFECTS IN SHAPE OF JAW

Gumboil, or alveolar abscess, is usually the result of inflammation at the root of a decayed tooth, and is due to suppuration spreading from the tooth into the gum around its root. The face on the affected side becomes swollen, and is very painful. If any redness develops on the cheek outside, it is certain that there is pus there which should be let out, as it may burst of its own accord through the cheek. The gumboil may be brought more quickly to a head by the application of warm fomentations. When there are signs of redness on the outside of the cheek the sooner the gumboil is opened by the doctor or dentist the better; this opening is usually made inside the mouth, and healing up very soon occurs.

It should not be forgotten that diet plays an important part in the hygiene of the teeth and gums. A lack of Vitamin D, which is found in fresh milk, and more abundantly in cod-liver oil, in the infant's or child's dietary undoubtedly causes mal-development of the teeth and gums, and predisposes to dental disease.

DENTAL CARIES OR DECAY.

The chief immediate cause of decay of the teeth is the stagnation of

food in the intestines, where it undergoes chemical changes which bring about destruction of the outer enamel. Once the enamel has been weakened the action of decay becomes very rapid, so that, unless the trouble is dealt with quickly, it may lead eventually to loss of the tooth. In the majority of cases there may be little or no pain during the early stages of decay; though very often, even then, slight tenderness may be felt when the tooth comes in contact with something hot or cold. As the decay spreads it leaves a cavity which is a danger to the general health, as it leads to the increase and multiplication in the mouth of dangerous microbes. Active inflammation may set in, causing severe pain of a throbbing character, in which case the patient may be driven to seek relief either in removal of the tooth, or in treatment to restore it to a healthy condition.

VIII—DISEASES OF THE HEART AND LUNGS

THE anatomy and physiology of the heart and the lungs have already been considered in detail, so we shall only mention again those anatomical and physiological facts which have a bearing on the heart and lung in disease.

The heart and lungs lie in the bony cage formed by the breastbone (sternum), the backbone (vertebral column), and the ribs. Their combined function is to remove carbon dioxide from the body, and to provide it with that essential ingredient of life—oxygen. Without a proper supply of oxygen no muscle or organ of the body can work efficiently. When the oxygen supply fails because of a diseased lung, a damaged heart, or narrowing of the arteries ('hardened arteries,' a condition called by doctors 'arterio-sclerosis'), then the body carries out its duties with difficulty. The muscles, called upon to make a little extra effort, tire easily. Breathing becomes hard. The business man finds he forgets things and cannot think as quickly as he did; and he sleeps badly. All this is largely due to a lack of oxygen. In addition, the kidneys and the bowels, because they cannot produce their maximum output unless oxygen-carrying blood is flowing freely through them, fail to rid the body of the 'natural' poisons formed by its working. These poisons accumulate in the system, and add to the general distress.

If a motor car is not driven with care and intelligence, and is not kept in good order, it soon finds its way to the scrap-heap. In some ways our hospitals are the scrap-heaps for badly driven human machines. If you want to keep off these scrap-heaps, give your lungs plenty of oxygen by getting out into the fresh air whenever possible. Keep your heart and blood-vessels tuned up by regular and not excessive exercise. Don't try to carry too heavy a load, and don't try to break any speed records unless you are properly equipped to do so. See that your machine is well lubricated, and has the right mixture of gas (food) and air (oxygen), and once in a while get it overhauled by a doctor. This is what is called preventive medicine—obvious advice, but often ignored.

THE HEART

In shape the heart is rather like a pear with an extra bulge on one side. It is a hollow muscular organ, divided into four compartments, lying behind the chest-bone and to the left of it; its rounded point or 'apex' can be felt beating just below the nipple. The heart is closely covered

by a 'skin' which, folded on itself, forms the pericardium. The pericardium is like a bag which has been pushed in at one end, and the heart sits in the cavity thus formed. The inside of this 'pericardial' bag is smooth and covered with a thin lubricating fluid, so that the heart can easily contract and expand in it. The right side of the heart deals with the impure 'blue blood' which is carried to it by the large veins (superior and inferior vena cava) entering the compartment called the right auricle. This blood passes via the right ventricle to the lungs, where it gives up carbon dioxide and takes in oxygen. The carbon dioxide is expelled when we breathe out, and the oxygen reaches the lungs when we breathe in. The bright red, oxygen-carrying blood then leaves the lung via the pulmonary veins, the only veins which carry bright blood, to enter the left side of the heart, whence it is pumped out into the main artery—the aorta. The aorta divides and subdivides into large arteries, small arteries, and finally into the smallest—called arterioles—which ramify throughout the whole of the body, supplying every cell of it with oxygen by way of those thin-walled tubes, the capillaries, which form a network between the arterioles and the smallest veins. The small veins carry away the exhaust gas, carbon dioxide, to deliver it finally to the lungs via the right side of the heart. The circulation, therefore, consists of a pump (the heart) and a closed system of tubes, the arteries and the veins, and the connecting link between the two, the capillaries. It is through the capillaries, the finest link in the circulatory chain, that the exchange of oxygen and carbon dioxide takes place, both in the lungs and in the tissues of the body. Through these capillaries, also, fats, sugar, proteins, mineral salts, vitamins, endocrine secretions, and hormones reach the cells of the body; and through them the breakdown products of cell activity are removed.

THE HEART IN HEALTH.

The healthy person who keeps himself fit goes through the day without being conscious that his heart is beating approximately seventy-two times every minute. He can run for a bus, go for a swim, and play a game of tennis without feeling unduly puffed or exhausted. There are, of course, wide variations in the heart's efficiency without any disease of the heart being present. The athlete who is carefully trained has greater powers of physical endurance than the office worker who is content with a little mild exercise during the week-end. A man who works overtime at his job, smokes too many cigarettes, and doesn't get out enough, may find himself out of breath after running up a flight of stairs. And he may suffer from palpitations—that is, he becomes conscious of his heart's beating. This does not mean that the heart is diseased, but it does mean that the heart-muscle has become flabby,

just as the muscles of the arms and legs become flabby if they are not regularly exercised.

It is most important that the heart-muscle should be kept in proper condition, for the efficiency of the circulation depends upon it. The most serious disease is not that which damages the valves of the heart, but that which damages the muscle, and the man who takes care that his muscle doesn't 'get soft' will stand a better chance in the struggle against disease than the man who fails to do so.

The girl who is anaemic may suffer from heart symptoms. (A symptom, by the way, means something complained of by the patient; a sign is a physical disturbance in the patient detected by the doctor.) The anaemia may result from a number of different conditions. It may be caused by an excessive loss of blood at the monthly periods. It may be evidence of some grave disease, such as pulmonary tuberculosis. It may be due to faulty habits of living and dieting. In the days of our grandmothers there was a common form of anaemia called 'green-sickness'; it was popularly thought to occur in the love-lorn maid, but was probably associated with a 'tight-laced' existence. Anyhow, it is rare in the modern girl, with her sensible clothes and her healthy demand for a more active life. Nevertheless, the pale languid female is not infrequently found behind the most perfect make-up, and she will complain, among other things, of palpitations of the heart, of breathlessness after ordinary exertion, and of lack of energy. The heart symptoms may colour the whole picture and raise alarm in the patient. The heart is not diseased, yet it cannot function properly because it is not being supplied with enough of the most important of all foods—oxygen. When the anaemia, and the cause of the anaemia, are effectively treated, then the heart symptoms will disappear.

If a man goes into strict training for some athletic activity he usually gives up smoking, and any one who has smoked excessively knows that he gets short of breath if he pursues a rapidly receding tram. Medical textbooks describe a condition called 'tobacco heart,' and there is plenty of evidence that excessive smoking nearly always has a bad effect on the heart. But excessive tea-drinking, excessive food-eating, or excessive idleness, are also bad for one. And there is no doubt that what may be excessive for one person is a trifling matter for another. Many people find tobacco a pleasant poison which makes life tolerable. It aids reflection and abets social intercourse. Those who condemn it as an evil are usually people who call every habit bad in which they do not happen themselves to indulge. Yet there is a certain amount of danger; and the wise man will discover the measure of his own tolerance for tobacco (as well as for alcohol), and live within it. Provided that he can carry out his normal activities, and play whatever game he does

play without unusual fatigue or breathlessness, then smoking is not doing him any harm.

A common symptom which is often thought by patients to indicate heart disease is pain over the heart. While this is, in fact, one of the symptoms of heart disease, when occurring by itself it is nearly always a symptom of indigestion, and has no connection with the heart at all.

HEART DISEASE: SIGNS AND SYMPTOMS.

The heart, as has already been pointed out, is a hollow muscular organ, the inside of which is lined with a fine 'skin' or membrane, the endocardium, that covers also the surfaces of the valves. The outside of the heart, it will be remembered, is invested by the pericardium. Disease may attack either or all of these structures. The most serious is that which attacks the heart-muscle, the driving force behind the circulation. In youth the commonest cause of heart disease is rheumatic fever, which, although the question has not been definitely settled, is believed to be due to a bacterial infection. After the age of fifty heart disease usually implies fatty or fibroid degeneration. This means that the healthy muscle substance is replaced either by fat or by fibrous tissue; the latter resembling the scar that remains after you have cut yourself. Just as the other muscles 'run to fat' if a man allows his sedentary occupation to get the better of him, so does the heart-muscle. 'A fair round belly with good capon lined' generally indicates a large fat heart, and while the former may be a token of external prosperity, the latter reveals internal bankruptcy. It is safer to be like Cassius and have a lean and hungry look.

A man goes to his doctor because he 'feels' that there is something wrong with him. The doctor's job is to discover whether there is any organic change (i.e. change from the normal in the organs of the body) to account for these feelings. The story the patient tells is of the greatest importance to the doctor, who is trained to distinguish the significant from the irrelevant details in the stories told by people who are sick, or who imagine themselves to be sick. Even people who imagine themselves to be ill do have something wrong with them—wrong with their imaginations. There are, on the other hand, people who imagine that nothing can go amiss with them. It is as foolish to turn a blind eye to danger-signals as it is to think that all signals mean danger.

One of the difficulties of the doctor is that he so often has to treat a patient who first seeks advice when his disease is already advanced. While there are not many diseases the doctor can, in the strict sense of the word, cure, he can often do a great deal for the patient in the early stages. He may be able to arrest the progress of an illness, and he can teach his patient how to live a useful life within the limitations imposed by it; and this is particularly true in cases in which the heart is damaged.

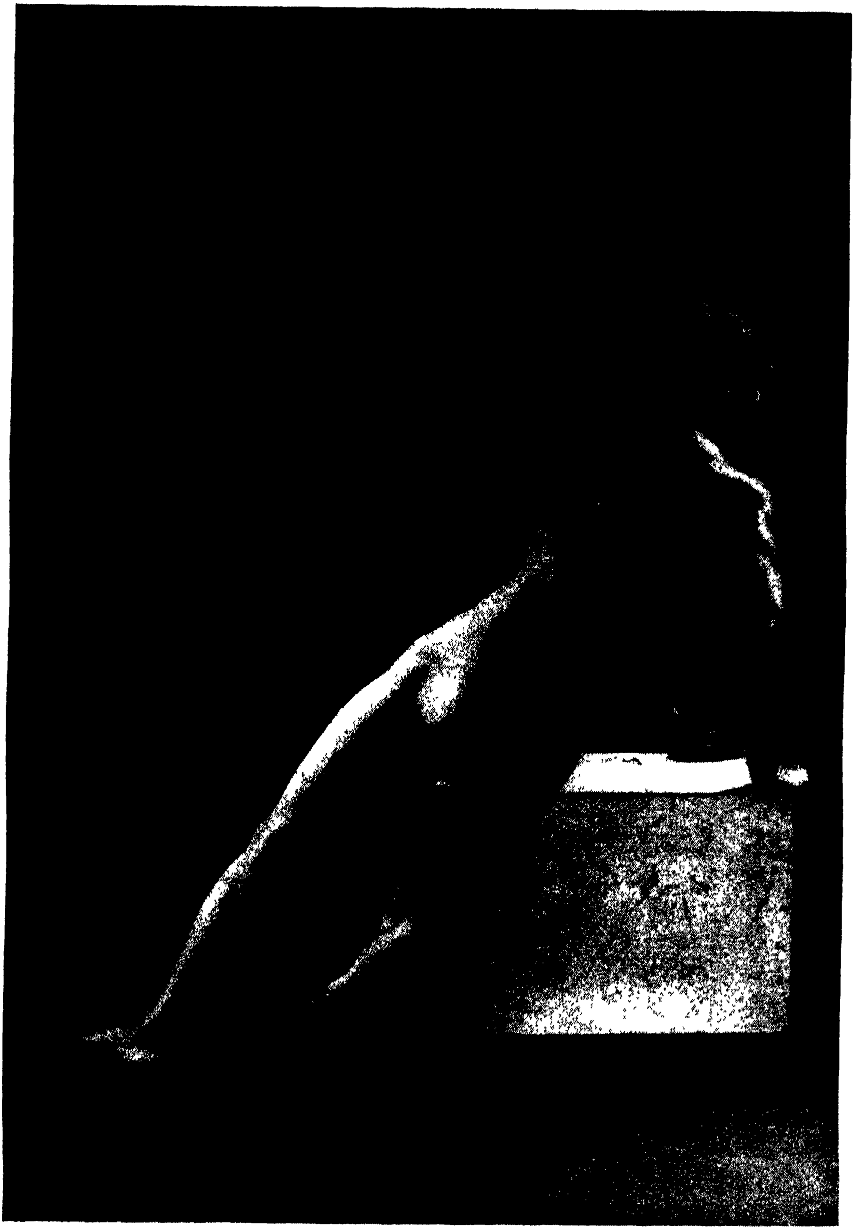
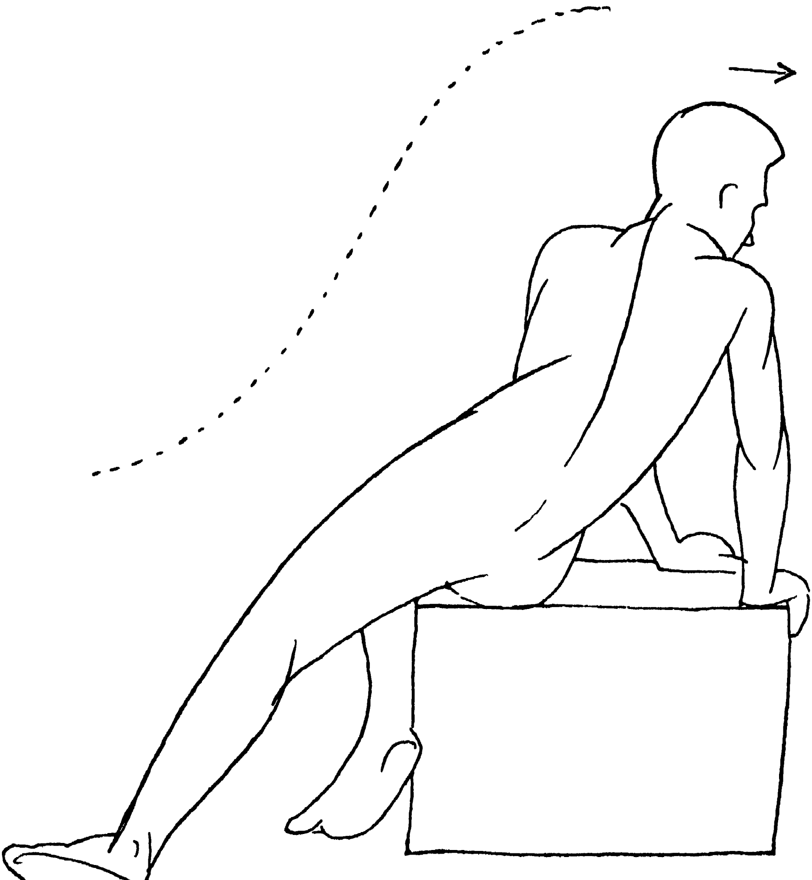


Photo by Herbert Williams

SPIRAL TWIST

'Follow-through' action



SPIRAL TWIST

The symptoms that should warn the patient that his heart is not working to full capacity are these. He finds that he gets easily breathless on exertion, that he has to slow down while walking up that slight hill to his house, whereas formerly he was able to take it comfortably in a rapid stride. Towards the end of the day, he may notice that his feet are too big for his boots, that they tend to swell. He complains that he tires easily. After a time he may develop a troublesome cough, which he finds it difficult to get rid of. He may even cough up a little blood. He will be conscious of his heart's beating after slight exercise —palpitations—and on arriving at the top of the hill he may feel a pain over his heart. When he enters the house he sees that he is a bit blue, about the lips. Later on other troubles may arise. Sleeplessness indigestion, constipation, attacks of breathlessness in the middle of the night, may, some or all, afflict the unfortunate sufferer.

The early symptoms of heart disease come on after moderate and accustomed exertion. Later they occur after the lightest exercise, and later still when at rest, so that the patient may find it difficult to breathe even when lying quietly in bed. The symptoms of heart disease often closely resemble those of disease of the lung, and in early cases one of the doctor's problems is to decide which organ is at fault. The severity of the symptoms, the prominence of some, and the absence of others, help him in this decision, and give him important information as to the seriousness of the disease. Not only do symptoms guide the doctor in the direction of right diagnosis, but they help him to determine the course of treatment to be followed. That is why doctors ask many questions which to the patient may seem pointless.

When the heart is diseased it often beats in an irregular manner, and the patient may be aware of this. He may be able to state the exact time at which the heart began to behave in this curious way (see below). There is a common and harmless form of irregularity which may cause alarm to the person in whom it occurs. The heart may feel as if it is turning over inside the chest. This is due to an extra contraction (extra-systole) thrown in between two regular beats. It is rather as if the heart gave a sudden jerk. It is nothing to worry about, as it often occurs in nervous people; it may be caused by too much smoking, too much tea or coffee, or by indigestion.

HOW THE DOCTOR FINDS OUT WHAT IS WRONG.

The physician, having from the story the patient tells him made a provisional diagnosis that there may be something wrong with the heart, proceeds to a physical examination. This will include a general 'overhaul' of the patient and a detailed investigation of the heart and circulatory system.

An experienced doctor will be able to tell a good deal from just looking

at his patient, and when he sees a man sitting in front of him with blue lips and breathing with difficulty it is obvious to him that here is a case of heart disease or lung disease. The actual abnormal conditions that may cause these symptoms are various; and the physician's task, when he has completed his investigation, is to analyse his findings, and make an accurate diagnosis of the particular condition from which his patient is suffering, for upon an accurate diagnosis proper treatment will depend.

When the heart beats, it pumps out a quantity of blood into the huge artery arising from it—the aorta. The aorta, it will be remembered, divides and subdivides into the numerous arteries which supply every part of the body with blood. This system of arteries has to accommodate at each beat of the heart the quantity of the blood which is pumped into it with a certain force, and at a certain velocity. The arteries do this by expanding, which they can do by virtue of their elasticity. In between the heart-beats, the arteries relax again. This alternate expansion and relaxation of the arteries, or pulsation, can be felt when any artery comes near the surface of the body. One such convenient place for the doctor is the wrist. By feeling the artery at the wrist he can count the number of times it expands—that is, the number of the times the heart beats—in a given time. The accepted standard of measurement is the frequency with which the heart beats in a minute. In most forms of heart disease the heart beats too quickly, and the 'pulse' is said to be 'rapid.' In addition to this the doctor can form some estimate of the pressure within the artery: that is to say, he can gauge the relation between two factors—the force with which the blood is pumped out of the heart and the resistance with which it meets in the arteries. Hence he can tell whether a patient is suffering from high blood-pressure or low blood-pressure. In a common form of heart disorder the heart beats irregularly, and this irregularity can be detected by feeling the pulse. Apart from these things the physician can feel the artery itself; and can thus find out whether the artery is thickened or hardened (arterio-sclerosis). He knows that if the artery at the wrist is hardened other arteries in the body are probably hardened as well.

When the heart fails to do its work properly, or when there is some obstruction in the valves of the heart impeding return of the blood to it, then blood stagnates in dependent parts, and its fluid, so to speak, oozes into the tissues. That is why the feet swell in heart disease: they become water-logged: this condition is known as dropsy. In advanced heart disease fluid may collect in the cavities of the body, in the chest, and the abdomen, and may have to be 'tapped,' or drawn off, by the surgeon.

The essential fact about most heart disease is the inability of the heart muscle to contract efficiently. The driving force of the pump is thus impaired, and the organs of the body fail to receive their proper supply

of blood—that is, of food and oxygen. When the heart-muscle becomes weakened, the pressure of the blood within the cavities of the heart distends it more than usual, and it dilates. The heart gets bigger, balloon-wise, and the first thing a doctor has to find out when he examines the heart is whether or not it is enlarged. A heart larger than normal is almost certainly diseased. The doctor estimates the size of the heart by feeling its thrust against the chest wall and by tapping or percussing the chest; whilst by placing his hand over the heart he can also judge the strength of its beat. Through the stethoscope he has to determine the nature of the heart-sounds, and to listen for abnormal additional noises called murmurs. Normally there are two heart-sounds. The first is caused mainly by the contraction of the heart-muscle as it expels the blood from its cavities. The second is due to the closure of the valves which guard the orifices of the two main arteries leaving the heart—the pulmonary artery and the aorta. If you say aloud the words 'Lubb-Dup,' that is the sort of noise the heart makes when it beats. If the heart-muscle is contracting feebly the first sound will be weak. If the valves are diseased and don't close properly—that is, if there is a leak through them—or if they become thickened and adherent, thus narrowing the valvular opening, various hissing and blowing noises called murmurs will be heard through the stethoscope, which will tell the doctor which valves are affected and to what extent. The final point in his examination is the measurement of the blood-pressure by means of an instrument with the ugly name of sphygmomanometer. Normally the blood-pressure in the main artery of the arm is equivalent to that needed to support a column of mercury, about one hundred and twenty-five millimetres in height, during contraction of the heart, and a column of about seventy-five millimetres during its relaxation.

By piecing together all the evidence he gathers from the patient's story and from his physical examination, the physician is able to decide whether the heart is diseased, which of its structures are affected, how far the mischief has gone, and so on. He is then in a position to prescribe treatment.

SPECIAL METHODS OF EXAMINATION.

Many cases, however, present points of difficulty, and even where the general diagnosis is not in doubt, more exact information about the condition of the heart is frequently invaluable. One of the most useful ways of obtaining this extra knowledge is by means of the X-ray photograph and the X-ray screen. By looking at the heart's shadow on the X-ray screen the physician can watch its beat and observe its shape. By special means he can measure accurately the width of the heart. The X-ray photograph will show whether it is normal in size and shape, and

will reveal any enlargement of its various parts and any abnormality of the aorta.

Another important instrument for 'checking up' the heart is the electro-cardiograph. This is an instrument which gives a photographic representation (by photographing the vibrations of the string in the string galvanometer) of the electrical changes that take place when the heart contracts. It is known that when any muscle contracts the contraction is accompanied by an electrical change in the muscle. In the normal heart the photograph of this change presents certain constant features: in disease this constancy is disturbed. Not only is this method of investigation useful in most cases of heart disease, but in some it is absolutely essential if a correct diagnosis is to be made.

This brief account will have given the reader a general conception of the problem with which the doctor is confronted in his investigation of a case of heart disease, and of the way in which he deals with it.

SOME CONDITIONS CAUSING HEART DISEASE.

One of the gravest and most common forms of heart disease is that caused by rheumatic fever, often vaguely called rheumatism. It most often affects children and young adults, and typically manifests itself by pain and swelling of several joints, fever, and a general feeling of illness. Frequently, however, rheumatic fever begins, not as a sudden dramatic event, which sends the patient straight to the doctor, but as an indefinite disorder of health. This is especially so in children. The child may be fretful, peevish, run down, anaemic, and may have vague pains in the legs and arms, which are usually dismissed by the parent or school teacher as 'growing pains.' A child with definite growing pains (so-called) should always be examined by a doctor, as more often than not they are a sign of rheumatic fever. The child may suffer from attacks of sore throat, and there is no doubt that sore throat, or tonsillitis, has a connection with rheumatic fever. When a child has repeated attacks of tonsillitis, it is advisable to seek a doctor's advice as to whether the tonsils should be removed.

Although in rheumatic fever the joints of the arms and the legs are affected and may swell, they are never permanently damaged. Once the swelling has gone down the joints are normal again. Whatever causes rheumatic fever (many doctors think it is a germ) often attacks the heart as well as the joints, and herein lies the gravity of the disease, because the heart, once thus attacked, rarely fully recovers. This does not mean that all people who have rheumatic fever end up with heart disease, nor does it mean that even if the heart is affected the patient will, necessarily, be severely incapacitated. Nevertheless, there are a great number of heart cripples in England, and the consequent waste of valuable human lives is serious. Damp, dark, airless rooms and

insufficient or unsuitable food undoubtedly are potent agents in lowering the resistance of children to this disease. Rheumatic fever may injure any or all parts of the heart, the pericardium, the muscle, and the valves (causing valvular disease of the heart). Another condition which is probably caused by the 'poison' of rheumatic fever is 'St. Vitus's dance,' or chorea, in which the child makes purposeless, irregular, jerky movements of the limbs and the body. In this disease, also, the heart may be affected, and if only for that reason no parent of a child so affected should neglect to consult a doctor.

In all acute infections, as, for example, typhoid fever, there is an abnormal strain on the heart, and in some conditions its state may cause the physician a good deal of anxiety. In diphtheria, the heart may fail as a result of the action of the poisons or toxins of the diphtheria bacillus on the heart-muscle itself, or on the nerves supplying it. These toxins may also damage another part of the circulatory system—the thin-walled, delicate capillaries. The doctor guards against the dangerous complication of heart failure in diphtheria by keeping the patient flat on the back, and so lessening the strain on the heart, until the danger is past. In scarlet fever the valves of the heart may be affected, but this is not common. In all lung diseases a strain is thrown on the heart, and this is particularly so in pneumonia. The reason for this will be readily understood when it is remembered that the right ventricle of the heart pumps blood through the pulmonary artery into the lungs, where it gives up carbon dioxide and takes up oxygen. If the lung is solid as a result of inflammation, as it is in pneumonia, it will offer to the flow of blood through it a resistance which must be overcome by increased activity on the part of the right side of the heart. In pneumonia, also, the heart is directly affected by the toxins of the pneumococcus (the bacterium which causes pneumonia), so that in this disease it is fighting at a double disadvantage, and presents the physician with a difficult problem of treatment. There is an uncommon and serious form of heart disease, called infective endocarditis, in which bacteria grow on the valves of the heart, from whence they are liable to be dislodged and travel by the blood-stream to form small abscesses in various parts of the body.

The micro-organism of syphilis may attack the aortic valves, which guard the orifice of the aorta where it springs from the left ventricle, or the aorta itself. More rarely it attacks the heart-muscle. Syphilitic disease of the aorta weakens its walls, so that the aorta gives way under the pressure of blood within it, and dilates into a thin-walled swelling called an aneurysm. This aneurysm may burst, with fatal consequences. Syphilis of the heart and the aorta is one of the gravest complications of this destructive disease.

In referring to the heart in pneumonia we spoke of the extra strain

put upon the right ventricle in forcing the blood through the pulmonary artery against resistance in the lung. This strain is present in all chronic lung disease, especially in that ailment so common in England—chronic bronchitis. A patient suffering from this disorder is breathless first on account of the bronchitis and, sooner or later, in addition, because of some weakening of the heart as a result of long-continued over-exertion. The physician has the difficult task of determining how far the patient's distress is due to the lungs and how far to the heart. He often has the equally difficult job of persuading his patient to follow a line of treatment for which that patient can see no reason—treatment aimed at resting the heart (which usually means resting the whole body) as much as at relieving the lungs. Here again it is necessary to emphasize that not every one with chronic bronchitis has a weak heart. Another disorder in which the heart has to work to excess is Graves' disease, or exophthalmic goitre. In this condition operation on the thyroid gland is often found to be the only way to ease the heart, and to treat the disease.

We often read of some person who has 'dropped down dead in the street.' This often results from the sudden formation of a clot in one of the arteries supplying the heart-muscle with blood. This is called coronary thrombosis, because the clot forms in the coronary artery. The heart, suddenly deprived of blood, and therefore of food and oxygen, is unable to go on beating, and death ensues. If only a small branch of the coronary artery clots, the patient may recover, but the outlook is always grave.

VALVULAR DISEASE AND PERICARDITIS.

In the section on physiology it was pointed out that the valves of the heart guard the exits from and entrances to its various cavities to ensure that the blood shall flow in one direction only. If the valves become diseased, as a consequence of rheumatic fever, syphilis, or arteriosclerosis, they will be unable to close properly, and they will leak. This throws an extra burden on the chamber of the heart behind the leak. Sometimes the valves become thickened and stiff, and narrow the orifice between, say, the left auricle and the left ventricle, impeding the flow of blood from the former to the latter. Whether the valve-opening is narrowed, or whether it leaks, the result is in some ways the same: the muscle-fibres enlarge (hypertrophy), and the heart 'puts on muscle' to deal with the extra work it has to perform. Valvular disease in itself is no cause for great alarm. The outlook for a patient suffering from it depends upon the state of the heart-muscle. If the muscle is only slightly affected (and it is always affected to some extent when the valves are diseased) then it may be capable of compensating, by more vigorous action, for the difficulties caused by a leaky or narrowed valve.

The valves commonly affected are the mitral valves (between the left auricle and the left ventricle), and the aortic valves (between the left ventricle and aorta).

Just as the inside lining of the heart (endocardium) may become inflamed, so may the outside (pericardium). Such inflammation may complicate rheumatic fever, pneumonia, and tuberculosis, as well as other diseases. It may be a 'dry' inflammation, or it may be accompanied by an effusion of fluid into the sac formed by the two layers of the pericardium. It is usually an extremely painful and serious complication, and the fluid that forms may have to be drawn off by puncturing the sac with a hollow needle.

DISORDERS OF RHYTHM.

As has been explained in the section on the physiology of the heart, the heart beats in a steady, regular rhythm, each stimulus to contraction starting at the sinus node, and spreading over the auricles; the stimulus to contraction then passing down the special conducting tissue—the bundle of His—to the ventricles. If there is any short-circuit in this conducting tissue, the stimulus to contraction will become blocked and take another route, and the heart will beat in an abnormal manner. Interference can occur at the starting point of the contraction-stimulus (the sino-auricular node), in the auricular muscle, at the auriculo-ventricular node (where the impulse to contract is picked up from the auricles), and in the bundle of His, which transmits the impulse to the ventricles. If this last structure is damaged, the impulse from the auricles to the ventricles may be blocked partially or completely (heart block). In complete block, the ventricles continue to beat independently of the auricles and at their own rhythm, that is to say, at about half the frequency of the auricles or approximately thirty-two times a minute. It is obvious that this condition limits the range of the heart's activity when called upon to make an extra effort. More serious are the facts that it is usually associated with lesions elsewhere in the heart, and that it may be accompanied by convulsive seizures.

The commonest form of irregularity of the heart-beat is a condition known as auricular fibrillation. It is a frequent complication of rheumatic heart disease, exophthalmic goitre, and the degenerative heart disease of old age. The stimulus to contraction pursues a completely irregular course round the auricles, with the result that the individual muscle-fibres of the auricle beat out of tune, each one beating for itself, and the auricles fail to contract as a whole. Fortunately this disorder can to a great extent be brought under control by a drug called digitalis, made from the leaves of the fox glove. There are many other disorders of rhythm, but this example will give a general idea of how these disorders are brought about. It need hardly be said that any one conscious

of an irregularly beating heart should seek a doctor's advice, but it is as well to point out that some slight irregularity, due to extra beats, is not uncommon, and is usually of little significance.

TREATMENT.

A patient with heart disease may often carry on his work for years before he is compelled by shortness of breath, cough, swelling of the legs, pain over the heart, etc., to give it up. When these symptoms show themselves, the heart is failing to satisfy the needs of the body, and the physician's help is needed. There is no specific 'cure' for heart disease, as we may reasonably say that there is for diphtheria. The doctor dealing with a patient with heart failure has to treat, not only the heart condition itself, but the whole patient. This means, in effect, a complete reorganization of the patient's existence. Sleep, food, work, rest, exercise, have all to be ordered and regulated with a view to minimizing the strain on the diseased heart, and to bringing the patient back to a maximum state of efficiency, within the limitations set by the disease itself. The physician has before him the problem of gauging these limitations, and of judging the pace at which his patient can profitably and safely live once the disorder of the heart is stabilized; a problem the solution of which is possible only if the doctor has the full co-operation of the patient. The business of getting well and keeping well is something which needs intelligence, courage, and perseverance on the part of both. If the patient has some understanding of the case, as the doctor sees it, he will so much the more readily and easily help the latter in the task which so vitally concerns them both.

The diseased heart is a heart that quickly tires, and it needs rest. The only way to rest the heart is to rest the patient, and this often means weeks or even months in bed. This is usually a prospect which the patient does not like to face. He expects the doctor to give him some magically-healing drug which will put him on his feet in a trice. Such drugs do not exist, except in the advertisement columns of the newspapers. There are, of course, many drugs, the most important being digitalis, which the doctor can usefully employ in helping the heart back to a more healthy way of functioning, but drugging constitutes only one move in his plan of campaign. Even when 'heart failure' has been successfully treated, and the patient is once more able to think about getting back to work, he must be guided by the physician as to how much work he can do, and as to what manner of life he must lead, if he is to keep within the limitations imposed upon him by a heart that can never again be completely normal.

HIGH BLOOD-PRESSURE AND ARTERIO-SCLEROSIS.

High blood-pressure—which means that the pressure exerted by the blood on the walls of the arteries is higher than normal—is a common

condition. The actual cause is not known, but there is little doubt that it is closely associated with the conditions of modern life. It is part of the price man pays for his civilization. Mental stress and strain, the tension created by living in a fiercely competitive society, the temptations of the world, the flesh, and the devil (the devil, often, of ambition), quicken the pace at which a man lives and tax his natural resources of energy. He lives tuned up to too high a pitch and loses his capacity for relaxation.

In high blood-pressure, the small arteries, the arterioles, and the capillaries, especially those of the kidneys, undergo various changes which narrow their bore. This increases resistance to the flow of blood through them, and to overcome this resistance the heart beats more powerfully and the pressure of blood rises. As a consequence of this extra work the heart enlarges. Later, degenerative processes take place in which globules of fat and calcium are deposited in the walls of the blood-vessels. Two things may then happen. An artery, thus weakened, may give way under the increased pressure of blood, and a haemorrhage may occur: a common situation for such an accident being the brain. Or, alternatively, the artery may become so narrow that a clot forms within it, causing the local 'death' of the part dependent on the artery for its supplies. If this clot appears in one of the arteries leading to the heart-muscle itself, sudden death may ensue. If it forms in a blood-vessel in the brain the patient may be paralysed.

The heart, the blood-vessels, and the kidneys really constitute one system, in the sense that together they keep all the tissues and organs of the body supplied with blood of a certain quality and quantity. They have been called the pump (heart), the tubing (arteries), and the filter (kidneys). The kidneys help to regulate the quantity by getting rid of any excess fluid, and the quality by eliminating the by-products of bodily combustion. Disturbance in any part of this system leads to disturbance in the other parts, and so in high blood-pressure the kidneys are frequently damaged.

The middle-aged man or woman who begins to suffer from headaches, failing memory, insomnia, fatigue, shortness of breath, indigestion, constipation, irritability, and misty vision, should go at once to a doctor. The illness is often thought merely to indicate that the patient is 'run down,' and advice is not sought. An early visit to the doctor may make all the difference to life and comfort, for these symptoms are likely to indicate high blood-pressure and hardened arteries.

One very distressing condition sometimes associated with high blood-pressure and arterio-sclerosis is that called angina. In this the patient has sudden attacks of pain over the heart, and down the inside of the left arm, which attacks come on after exertion. A man walking up a hill or against a cold wind may suddenly be compelled to stop on account

of the pain, which is often agonizing. As the seizures are frequently accompanied by indigestion, the patient may think this to be the cause, and therefore defer a much-needed visit to his doctor.

High blood-pressure, then, and the arterio-sclerosis that nearly always goes with it, may show themselves by failure of the heart, or of the kidneys, or of the arteries (clotting or rupture). The pump, or the tubing, or the filter may give way under the strain. The best way to keep oneself from these disasters is by avoiding excesses of food and alcohol, by eating a balanced diet with plenty of fresh fruit and vegetables, by taking moderate and regular exercise, and by avoiding mental and emotional strife. 'Plain living and high thinking' is a counsel of perfection, and difficult to carry out, but it should be followed, even at a distance; whilst if every man and woman were to set aside one hour each day in which to relax completely, they would gain enormous benefit.

THE HEART IN OLD AGE.

The changes that take place in the arteries in arterio-sclerosis lead, amongst other things, to a cutting down of the food and oxygen ration to the parts supplied by the diseased arteries. One result of this is that the more specialized cells die and are replaced by fibrous tissue; or, alternatively, small fat globules appear within them (fatty degeneration). When the arteries supplying the heart become arterio-sclerotic, as they not uncommonly do in late middle age and old age, the heart undergoes this fibroid or fatty degeneration. In obesity there is a general increase of fat all over the body, as well as in the heart, where the strings of fat, so to speak, strangle the muscle-fibres. The result is the same in all these cases: a disappearance of healthy muscle-tissue, and its replacement by fat and scar tissue, leading to impairment of function and, finally, to heart failure.

DISEASES OF THE RESPIRATORY TRACT

The respiratory tract begins at the nose and ends in the lungs. Air breathed in passes through the nasal passages, down the back of the throat, past the larynx, over the vocal cords, down the trachea (windpipe), and the two stout tubes (bronchi), which branch off from it, and so into the air-spaces of the lungs. The air breathed out passes in the reverse direction. These air passages are lined with a delicate membrane or skin which secretes mucus, and this mucous membrane, as it is called, is exposed to the dust and the fog one is compelled to inhale in big cities, as well as to bacteria. In fact, the mouth and the throat swarm with bacteria, which in favourable conditions of health lead to no

harm. Dust particles get caught in the sticky mucus secreted by the lining membrane of the air passages, and little hairlike processes (cilia) projecting from the cells of the membrane move rhythmically away from the lungs towards the mouth, helping to eject the matter held by the mucus. Collections of lymph tissue at the back of the nose—the adenoid tissue—and in the tonsils serve, in a sense, as filters which restrain bacteria from going any further. These structures may become so damaged that they may have to be removed, but it is well to remember their primary protective function. The mucous membrane which, we have seen, lines the cavity of the nose, the throat, the larynx, the trachea, and the bronchi—in other words, the whole tube which leads to the lungs—also covers the surfaces of certain air-containing cavities in the bones of the face and the skull. There is one such cavity in each of the cheek-bones, and also in the part of the skull behind and above the eyebrows: nasal sinuses, as they are called. These are liable to infection, which may cause serious trouble, necessitating an operation by a surgeon.

The lungs are enclosed in the bony cage formed by the breastbone, the backbone, and the ribs. They are shut off below from the abdomen by a wide strong sheet of muscle called the diaphragm, and above by the tissues at the root of the neck. The thin-walled air-spaces of the lungs communicate with little muscular tubes called bronchioles, these collect into larger tubes, and these in turn connect up with the two main tubes (the bronchi), which join to form the trachea or windpipe. The trachea, bronchi, and lungs are rather like a beech tree upside down, and the noise the air makes when it enters and passes out of the lungs in respiration is not unlike the rustling sound of the leaves of a tree shaking in a gentle breeze. You can hear this if you put your ear close to another person's chest.

The lungs are closely enveloped by a fine skin called the pleura; and at the root of the lung, where the bronchus and pulmonary artery enter it, this pleura is refolded on to the inside of the chest wall, which it lines. The pleura is thus rather like a deflated football in the concavity of which the lung rests, much as the heart rests in the pericardium.

THE LUNGS IN HEALTH.

The normal adult goes about his daily business without being aware that he is breathing at the rate of between sixteen and twenty times a minute. If he does not suffer from adenoids or a very heavy cold he breathes with his mouth shut, and the particles of dust and soot in the air get caught up in the sticky mucus in the nose, which afterwards is blown out on to the handkerchief. In proper breathing through the nose the air is also warmed in its slower passage through the nostrils. The healthy breather will carry himself erect, with his head held a little

back and his shoulders straight. The man who stoops, with his back bent and his chin tucked into his collar—the man who looks as though he carries the weight of the world on his shoulders—is an inefficient breather, and is open to any infection that happens to be going about. He denies his lungs their right to full exercise, and doesn't give the red blood corpuscles a fair chance to pick up their quota of oxygen as they circulate from the right side of the heart, via the lungs, to the left side of the heart. It is obvious that many people do not know how to breathe properly. The question of posture is important, especially for children; for the child who droops will grow up into a sour-faced, stooping, bronchitic adult. The round-shouldered boy or girl may be round-shouldered because the muscles are weak, and the muscles may be weak because the child is unduly fatigued by too much work or too much sitting. Rest, correction of faulty posture, and appropriate exercises will make all the difference in the world to a child's health. It is important to remember that breathing is a vital function. The black-coated office worker who insists upon his two-mile walk a day in the open air is better armed against lung disease and coughs and colds than the man for whom the underground railway provides a warm place in which to sit during his transport from the office chair to the suburban comfort of stuffy upholstery and a gas fire.

LUNG DISEASE: SIGNS AND SYMPTOMS.

In this section we are more concerned with the lungs than with the other parts of the respiratory tract—the nose and throat and the larynx—and the diseases we shall discuss are more particularly those which affect the bronchi and the lung-tissue itself. The commoner of these diseases are bronchitis, pneumonia, and pulmonary tuberculosis or consumption. Other less common but not infrequent chest conditions are complications of one or other of these three. These will be discussed more fully later.

Probably very few people go through an English winter without a cough or a cold, and it is clear that a cough will be a common and prominent symptom in a patient who has something wrong with his bronchial tubes or his lungs. Coughing is a protective mechanism, and therefore useful. It serves to expel from the lungs and the bronchi matter which shouldn't be there. Yet a patient may have definite disease in the lungs without coughing at all—though this is uncommon —whilst on the other hand a cough may, and frequently does, mean nothing more than that there is a slight infection of the bronchi, which will clear up under ordinary home treatment. Or, again, it may mean merely that the patient is smoking too much. The cough that follows on a cold usually indicates that there is a slight bronchitis, or that the nasal discharge from a cold has passed down the back of the

throat to the trachea and the bronchi, from which it must be coughed up. This kind of cough generally disappears in two or three weeks, and it is a complaint for which each patient generally has his own pet remedy: it may be onions, it may be whisky. But the cough which persists for one month, two months, three months, or longer, must be taken more seriously. An early visit to the doctor is essential, for in the early stages of lung disease, such as tuberculosis, a great deal can be done. Two or three months' delay may make all the difference between a speedy recovery and a prolonged illness.

With cough usually goes expectoration, the sputum spat out being the mucus secreted by the mucous membrane, mixed with specks of dust and soot, a few cells, and bacteria. In one serious form of lung disease (bronchiectasis) the sputum has an offensive smell. Sometimes the sputum may be tinged with blood, or blood alone may be coughed up. In either case it is imperative to seek a doctor's advice as early as possible. It is true that the blood may have come from the gums, or the nose, or the back of the throat; but the commonest conditions in which blood spitting occurs are lung disease and heart disease; and the commonest lung disease of which blood-spitting is a symptom is pulmonary tuberculosis. Shortness of breath as a symptom of lung trouble is usually complained of when the disease is already well advanced. It is a common symptom in the patient who has had chronic bronchitis for years.

Pain in the chest which is aggravated by breathing is a sign that the pleura covering the lung is inflamed—the condition being called pleurisy. During respiration the lung expands and relaxes within the cavity of the chest, and to facilitate this a thin lubricating fluid is secreted by the pleura, which both covers the lungs and lines the chest wall. If a portion of the pleura becomes inflamed—red, swollen, and rough—the continuous movement of the lung rubs this patch and gives rise to pain. If you have an inflamed knee joint you can minimize the pain to a certain extent by keeping the joint still; the lung, unfortunately, has to go on working.

Cough, expectoration, pain in the chest on breathing, and breathlessness are, then, the main symptoms that warn the patient he has something wrong with his lungs. If these symptoms come on acutely, and the patient is feverish, it is probable that he is suffering from pneumonia; if they come on gradually over a period of weeks or months, the doctor has to think of the possibility of pulmonary tuberculosis. In the latter case there is usually a history of loss of weight, loss of appetite, loss of energy, dyspepsia, etc., which gives the physician a clue to what is wrong. He can, however, only arrive at a correct diagnosis by taking into consideration the statements of his patient, the results of physical examination, and the various special tests he may think

necessary to carry out. The way in which the doctor approaches the problem has been fully dealt with in the section on heart disease, and we will now briefly consider the kind of information he obtains when seeking to determine the nature and extent of disease of the lungs.

HOW THE DIAGNOSIS IS MADE.

If you tap or 'percuss' an empty wooden box with your finger you obtain a resonant note. If the box is filled with water or sand the note loses its resonance and becomes dull. A Viennese physician, Auenbrugger, who lived in the eighteenth century, found that percussion of the chest gave valuable information as to the condition of the lungs under the tapping finger. He wrote a book on the subject, but his medical colleagues refused to recognize the importance of this method of examination: to-day, of course, no patient who is examined escapes without having his chest percussed. The normal lung filled with air gives a characteristic note when the physician places one finger on the chest and strikes it with the tip of one of the fingers of the other hand. If a patch of lung is inflamed, contains less air, and therefore is more solid than usual, the note obtained on percussion will be duller: if there is fluid in the pleural sac the note will be stony dull. Percussion is a valuable help in mapping out the lung, and for detecting in it areas of diseased tissue.

The stethoscope, the symbol of the doctor's profession, was invented a little over a hundred years ago by a French physician, Laennec, who died of pulmonary tuberculosis, one of the diseases he so carefully studied. The modern chest physician owes a great debt to Laennec, for by means of the stethoscope he can determine the character of the breath sounds, and hear the abnormal sounds—bubbling noises of varying pitch and loudness—which are produced when air passes over the secretions which accumulate in the air spaces and the bronchial tubes when these are inflamed. If there is an effusion of fluid (as in wet pleurisy) into the pleural sac, the normal air sounds will not be heard; if the lung is solidified by inflammation, as in pneumonia, the sound heard through the stethoscope is characteristic; it is the sound produced by the air passing through the larynx (voice-box) and the trachea, the solid lung acting as a conductor. When the patient says '99,' this can be heard through the stethoscope applied to the chest: over a solid patch of lung the voice-sound will appear louder than over normal lung; if there is fluid in the pleural sac the voice-sound will disappear, or, if heard at all, will be like the bleating of a goat.

If we have an inflamed joint we tend to keep it still and to use it as little as possible. So with an inflammation of the lung. The physician, looking at the chest, and finding that one side moves less freely than the other, will conclude that the lung on the side which moves poorly

is inflamed. In lung disease of long standing, where the healthy tissue is replaced by scar tissue—the scar of old inflammation—the chest will tend to fall in and become deformed. In this case the heart may also be drawn over to the diseased side by the contraction of the scar tissue: the doctor can detect this by percussion, and by locating the position of the heart-beat with his hand. By looking, by feeling, by percussing, and by listening through his stethoscope, he will usually be able to find out what is wrong.

Exact diagnosis by these methods is, however, often very difficult, and modern science has given the doctor ways of confirming and checking his findings. By microscopical examination of the sputum he can find out whether tubercle bacilli or other germs are present. X-ray photographs of the lung will show up any densities in the lung due to disease. Tubes fitted with mirrors and lights can be passed through the mouth to the larynx and right down to the bronchi, and through these tubes the physician can inspect directly, as with a periscope, the state of these structures, and locate foreign bodies such as hair-pins, marbles, or false teeth, which may have by some accident entered the air passages.

There is a disease in which the bronchial tubes become, so to speak, blown out into cylindrical cavities—a condition called bronchiectasis. This is very difficult to make out on an ordinary X-ray photograph, but a process has lately been perfected in which a liquid called lipiodol —a mixture of poppy-seed oil and iodine—is injected into the wind pipe. The oil falls down into the bronchial tubes, and as it is opaque to the X-rays the abnormal shape of the bronchi is outlined on the radiograph.

SOME INFECTIONS OF THE RESPIRATORY TRACT.

Every one will agree that the man who discovers a cure for the common cold should have a statue erected to him in the most prominent place in London, and that the anniversary of his birth should be celebrated as a national festival. Until that discovery is made we shall most of us, once or twice a year, continue to be a misery to ourselves and a nuisance to our neighbours, and be driven to employ whatever remedy happens to be popular at the moment for the 'usual cold.'

A cold is an acute catarrhal inflammation of the mucous membrane which lines the cavity of the nose. Numerous germs have been blamed for this, but it is thought to-day that it is caused by a filter-passing virus or germ that is invisible under the ordinary microscope. Anyway, infection is spread from person to person, and one sneeze in a crowded railway carriage can rapidly increase the demand for handkerchiefs. In Samuel Butler's book, *Erewhon*, a cold was treated as a criminal offence, and if every one, on catching a cold, were to go into voluntary solitary confinement until the misery was over we should probably

be able to diminish its prevalence. The best remedy is prevention; and well-aired and well-ventilated rooms, with plenty of exercise in the open air, will go a long way towards maintaining resistance against this malady. In certain persons inoculation with vaccines is said to be of some use, but medical opinion and medical experience are far from unanimous on this point.

A cold becomes more incapacitating when it travels downwards, infecting first the larynx (laryngitis), when the voice becomes husky; then the trachea (tracheitis), causing a sore rough sensation behind the upper part of the breastbone; and then the bronchial tubes (bronchitis), making you wheeze and cough. If possible it is best to deal with this condition by spending a day or two in bed, taking a laxative, drinking plenty of fluids, and keeping warm.

BRONCHITIS.

Bronchitis is a frequent complaint in cold, wet, and foggy climates. There are many varieties, but it is sufficient to mention the ordinary acute and chronic forms. Acute bronchitis may occur at any age, but is commonest in infancy and old age. It is an acute catarrhal inflammation of the mucous membrane of the bronchi. It starts suddenly, with a tight feeling in the chest, a general feeling of illness, and a rise of temperature. The cough is at first dry and irritating, and later becomes loose, when expectoration is free. There is always a danger that bronchitis may develop into pneumonia, so it is important that any one with acute bronchitis should go straight to bed and send for the doctor. A warm well-aired room, hot drinks, a laxative, and a linseed poultice, or camphorated oil, to the chest, are domestic remedies that may be used by any one in the interim. Drugs should not be taken except on the advice of a physician.

One of the unfortunate results of acute bronchitis is that it may become chronic, and chronic bronchitis is common in late middle age and old age. It is naturally stirred to activity during the winter months, with periods of ease in the summer. It tends to become worse with each succeeding winter, with a chronic cough, expectoration, and breathlessness on exertion. Often associated with this is a condition of the lungs known as emphysema, in which the dividing walls of the alveoli or air spaces of the lung become broken down and distended to form little balloons on the surface of the lung. Calcium salts are not infrequently deposited in the cartilage of the ribs, and the ribs become fixed and only slightly mobile. All this makes breathing more difficult, and throws an extra strain on the heart. Patients with chronic bronchitis, therefore, must take all care to avoid exposure to wind or rain, and should keep themselves as fit as possible. In the event of an acute attack they should go straight to bed and seek medical advice.

PNEUMONIA.

Pneumonia is an acute inflammation of the lungs in which the air spaces become filled with an inflammatory exudate of fluid and cells, so that the lung becomes partially solid. This inflammation may attack a whole lobe of one lung, when it is known as a lobar pneumonia, due usually to infection with the pneumococcus; or it may attack patches of lung centred round the smaller bronchi, when it is known as broncho-pneumonia. Broncho-pneumonia is caused by a variety of germs, and is often a complication of bronchitis and other diseases. Lobar pneumonia usually starts with a shivering attack, and a severe cutting pain in the side. The temperature rises, breathing becomes difficult, and the expectoration is often tinged with blood. In favourable cases the crisis generally occurs about the seventh day of the illness, when the temperature suddenly drops. A not uncommon complication is for the pleura to become infected, and pus to collect in the pleural sac (empyema). An operation is necessary to drain this away. Pneumonia is a very serious disease, requiring for its treatment the most skilled medical and nursing attention. The administration of oxygen used to be considered a last hope in the treatment of the disease, but nowadays patients are often given oxygen by the nose as a routine measure; so that the appearance of the oxygen cylinder need not cause alarm.

CONSUMPTION.

Pulmonary tuberculosis, generally known as consumption, is an infection of the lungs by the tubercle bacillus. We need not go into the details of the different forms, beyond pointing out that acute 'galloping' consumption is now much less common than it used to be. Typically pulmonary tuberculosis is a chronic disease, which develops most frequently between the ages of fifteen and forty-five. It is a disease which comes on insidiously. The patient usually just feels 'run down,' on and off, perhaps, for months. The appetite is not so good as it used to be; fatigue comes on easily; there is a slight loss of weight and a mild degree of anaemia; there may be a slight cough with occasional sputum; some pain in the side may be noticed, which is aggravated by coughing or deep breathing.

These early symptoms are indefinite; no one symptom is usually so marked as to send the patient to a doctor. A frank pleurisy or an undoubted blood-spitting will, of course, immediately call attention to the lungs. Just as the symptoms in the early case of pulmonary tuberculosis are indefinite, so are the physical signs detectable in the lungs. The early inflammation of the lung caused by the tubercle bacillus when it settles there involves only a very small area. It is obvious that a patch the size, say, of the tip of the little finger cannot be

detected by the comparatively gross methods of physical examination the physician has to employ. Nor in these early cases is the X-ray photograph much more helpful, although in the radiograph the physician has a diagnostic instrument of supreme value. In the diagnosis of early consumption, then, the doctor is frequently faced with a difficult problem. He has the heavy responsibility of saying whether or not a suspected case is indeed one of consumption. The one sure proof is the finding of tubercle bacilli in the expectoration: but, again, these are not always present in the early case. Nor is this a purely academic matter, for the sooner a definite diagnosis can be made the better for the patient; and the doctor is always on the look-out for the early case in which he can, perhaps, prevent the mischief going further. But, of course, he has to have something stronger than suspicion to go on before he can make so serious a diagnosis, which always entails a long period of treatment and absence from work. The doctor, therefore, nearly always has to keep his suspected case of early consumption under observation. Repeated X-ray and physical examinations, the variations of the temperature chart, and of the weight record, and so on, all have to be reassessed from time to time in the light of the first complaints which brought the patient to the doctor.

There is no medicinal cure for consumption, but in the earlier stages the disease can usually be arrested and the patient restored to reasonable health and working capacity provided he conscientiously follows out his doctor's instructions. Treatment in the first place means rest in bed, followed, after the temperature has returned to normal and the other symptoms have diminished, by gradually increasing exercise over a period of months. It is important to remember that the only way to rest the lungs is to rest the whole body. The best place in which this controlled rest and graduated exercise can be carried out is the sanatorium, where at least a six-months' stay is usually necessary. There are further methods of treatment which in certain cases are invaluable. One of these consists in injecting air into the pleural sac, that is, between the chest wall and the lung, known as treatment with artificial pneumothorax. By this the diseased lung is compressed, and so given complete rest, on the principle of putting an inflamed joint in a splint. Various surgical operations, such as the removal of portions of the ribs on the diseased side, may be necessary, but these are, of course, matters to be decided by the specialist. They represent very definite advances towards the mastery of this grave disease.

PLEURISY.

Pleurisy—inflammation of the pleura—is characterized by a sharp attack of pain in the chest, which is made worse by breathing. It arises as a complication of inflammation of the lung, but it also occurs

as a separate disease by itself. It may be what is called a dry pleurisy, or it may be accompanied by an effusion of fluid into the pleural sac. When not associated with acute inflammation of the lung, pleurisy is usually due to tuberculous infection. It is, therefore, not a thing which can be neglected, and the doctor should be consulted at once.

One of the end-results of inflammation of the lung, whether this inflammation is tuberculous or whether it is a pneumonia, is the replacement of healthy lung tissue by fibrous tissue. This reaction is beneficial in pulmonary tuberculosis because the appearance of scar tissue is a sign of healing, and helps to seal off the diseased lung from the healthy. But extensive fibrosis of the lung, as it is called, leads to deformation of the chest and severe limitation of respiratory activity. If fibrosis follows pneumonia, especially the pneumonia of measles and whooping-cough, the bronchi may become swollen into cavities in which infected secretions accumulate. This may necessitate operation.

As the purpose of this section of the book is not to give a mere list of diseases, but to submit such an outline of disease-processes and of the way in which the physician carries out diagnosis and treatment as may help intelligent co-operation with him, we do not propose to discuss other less frequent forms of lung disease. But we may mention by name cancer of the lung, abscess of the lung, and the various dust diseases of the lung. The former two are said to have become more common in recent years, while the last, which especially affects workers in gold mines and quartz and slate quarries, constitute a grave industrial and medical problem.

IX—THE DIGESTIVE SYSTEM AND ITS DISTURBANCES

HUMAN energy, like that of any mechanical engine, needs for its production combustible fuel; and it is as fuel that our food may be biologically regarded. Without a continuous supply of food, no plant or animal can live. Supplying fuel to a human being is not, however, so simple a business as tending the fires of a steam-engine; the food we eat has to undergo a great many changes before our furnaces can make use of it. The various processes involved in bringing about these changes are collectively called digestion. In the first place, all our food, if it is to be of any use to us, must be turned into substances that will dissolve in blood; because, until it has been conveyed by the blood to the millions of cells all over the body where the actual combustion takes place, it is so much dross. Not only does it have to be made soluble, but it has to undergo extensive chemical changes; for only in certain forms, very unlike those in which our food naturally exists, can our tissues make use of it. Most of these changes are brought about by chemical substances which are poured into what is called the alimentary tract; that is, the long canal extending from the mouth to the anus through which the food slowly passes. The nature of these chemical substances—these digestive fluids—will be described in detail in the pages that follow. But one of their characteristics may be referred to here. The digestive juices are not simple chemical mixtures of acids and alkalis; but every one of them has an important constituent, a special ferment, or enzyme, as it is called, which has the effect of speeding-up chemical changes. To these enzymes various names have been given. Thus, the ferment in the saliva, which facilitates the change of starch into sugar, originally known as ptyalin, is now usually spoken of as amylase. Proteinases are the enzymes which act on proteins (such as white of egg or milk curd); and lipase is the ferment that facilitates the digestion of fat.

The first thing to realize about enzymes is that they are produced by the activity of cells, and that different cells are adapted in some obscure way to produce enzymes with different properties. That is to say, that cells in different situations say in the stomach or the salivary glands produce secretions, and in these secretions there are enzymes. The composition of these enzymes is not entirely known, but recent work suggests that they are protein in nature. Enzymes exist in secretions as colloids, and their activities are readily destroyed by heat; i.e. if an active enzyme solution be boiled the activity is destroyed. The enzyme content of any given secretion or extract

is measured not in terms of so much weight of enzyme, but in terms of the results of the activity. We shall return to this point. Enzymes may be *extra-cellular*, i.e. found in secretions or readily extracted by various means from the cells, or they may be *intra-cellular*, in which case they are not extractable from cells and we must test their activity by using the actual cell bodies themselves. In every enzyme reaction we have the substance which is acted upon, the enzyme and the products of the reaction. The substance acted upon is called the *substrate*, so we have

Substrate + Enzyme → Breakdown products of reaction

Now this reaction has many peculiarities, which we will consider shortly:

(1) As the reaction proceeds the enzyme slowly loses activity, but extraordinarily little enzyme can bring about big changes.

(2) As the products accumulate they react with one another, and tend to remake the original substrate, i.e. the reaction is reversible, and so finally an equilibrium is reached in which the rate of breakdown of the original substrate is balanced by the velocity of re-formation. But if the products of reaction are continuously removed, then the substrate will continue to be broken down until it has all gone. This is the course of events in digestion.

(3) The action of the enzyme is confined entirely to increasing the velocity of the reaction. Certain substances when placed in water will very slowly break down: the addition of the appropriate enzyme increases the rate of this to so great an extent that a few minutes may suffice to bring about changes which under ordinary circumstances may take days.

(4) Enzymes in general are distinguished by the substrate upon which they act, and are named by adding *-ase* to the name of the particular substrate. Thus *proteinases* are enzymes acting on proteins; *lipase* is the enzyme acting on fat; *saccharase* is the enzyme acting on saccharose or cane sugar, and so on. Some older names like *ptyalin*, *pepsin*, and *trypsin* are retained because of time-honoured usage.

(5) Enzymes depend upon their surroundings to a great extent. If the medium is too acid or too alkaline they lose activity very quickly. There is a range of temperature in which they act best, and outside this range the activity is relatively poor. Each enzyme has its own *optimum reaction*, and its own range of *optimum temperature*.

(6) Enzymes are remarkably specific, i.e. each has a particular substrate on which it will act, and no other is effective. Remarkably small changes in composition of the substrate are sufficient to make it immune from the attacks of an enzyme.

(7) Enzymes exist in every part of the body, and make possible a rapid sequence of reactions which would require very long and complicated processes if ordinary chemical means only were available. This power of so greatly increasing the speed of reactions is called *catalysis*, and enzymes may be called *organic catalysts*.

(8) Enzymes are in some cases produced in an inactive form. In such cases the enzyme is made active by adding a specific substance called a *co-enzyme*. These co-enzymes differ from enzymes in that they are *not*

destroyed on boiling, i.e. they are *heat-stable*, whereas enzymes are *heat-labile*.

In the body enzymes are produced in conditions best suited for the metabolic needs of the organism. We will consider each enzyme as it becomes relevant and important in the particular stage of digestion.

Digestion in the Mouth

Digestion begins in the mouth. If the food is solid, or partially solid, we grind it with our teeth and work it round and round the mouth, mixing it the while with the first of our digestive juices, the saliva. If a piece of unsweetened bread be placed in the mouth and thoroughly mixed with saliva, it becomes sweet in a relatively short space of time. Saliva is produced by the salivary glands (the parotid, lingual, and submaxillary glands), and the mucous membrane of the mouth. This juice or saliva contains a variety of substances, and is alkaline in reaction; though, if fermentation of carbohydrate has occurred in the mouth it may be acid. Saliva contains water and mucin, the latter being a protein of a sticky or slimy consistency, and hence helps in lubricating the mouth, and the oesophagus, i.e. the tube leading to the stomach. Next it contains a peculiar salt, potassium thiocyanate, which possibly has a mildly disinfectant action in the mouth. We are, however, rather doubtful as to its function. The saliva also contains salt, the value of which seems to lie in its power to aid the action of the salivar enzyme. This enzyme is called amylase or ptyalin. It is a very active substance and, even in small amounts, rapidly changes starch into a sugar, called maltose.

$$\text{Starch} + \text{Ptyalin} \rightarrow \text{Maltose } (+ \text{a little Glucose})$$

The same reaction occurs if we take a little boiled starch in a tube, add a little saliva to it, and keep the mixture warm for a minute or so. The starch quickly disappears, and in its place we find maltose. Since starch gives a blue colour with dilute iodine, whereas maltose does not, we can use this test to show that the starch has been changed. If, however, the mixture be boiled, cooled, and then left for some time, the starch does not disappear; for the ptyalin—like all enzymes—is destroyed by heat. Saliva contains no other enzymes, and therefore fat and protein kept in the mouth do not change.

Another constituent of saliva is calcium. By the interaction of this element with carbon dioxide we get depositions of carbonates of calcium on the teeth. When the dentist scales and cleans the teeth, he first of all mechanically removes what he can; and then brushes the teeth vigorously with hydrochloric acid, which dissolves away the lime salts.

If we wish to determine the amount of ptyalin in a given specimen of saliva or other fluid we use either of two methods. We can either find how long it takes for a certain amount of the enzyme solution completely to digest, i.e. change into maltose, a standard amount of starch solution, or we can find how much starch solution is changed to maltose by a certain amount of the enzyme solution. It is, by the way, an interesting fact that the consistency of the saliva is automatically so adjusted as to be best suited to deal with the particular substances placed in the mouth. For instance, if we take a mass of dry sand into the mouth, the saliva produced is rich in mucus, calculated to make the grains stick together so that they may be readily got rid of. On the other hand, if we take an acid substance, or a few drops of acid, into the mouth there occurs a free flow of watery saliva, poor in mucus, adapted to dilute the acid. Such stimulation of salivary secretion is not exerted directly on the salivary glands, but on the membrane of the mouth, from which messages pass to the brain-cells with which the salivary glands are in telegraphic communication. Such indirect stimulation is called reflex, and in these cases we talk of reflex salivation. The copious secretion of saliva which occurs when we smell or think of certain substances is clearly a very complex event. The transformation of thought processes into a secretory activity of a salivary gland is a manifestation of the close relationship between the mental life and the physical life of the individual, although it is only in a few mechanisms that we get so clear and obvious a proof of it.

Digestion in the Stomach

Except for the partial digestion of starch which takes place in the mouth, digestion proper begins in the stomach. Here changes occur which show that digestion consists in far more than merely preparing food for absorption. Recent researches have shown that the stomach produces in its secretions a substance which is of the utmost importance in the proper maintenance of the blood, and that this substance fails to be produced in cases of the dangerous disease, pernicious anaemia. It appears that the gastric glands, in addition to producing the enzymes and other factors necessary for gastric digestion, also produce what has been called, or miscalled, the intrinsic factor in blood production. This acts upon the protein of meat, and leads to the formation of a substance (as yet of unknown composition) which is absorbed from the intestine, passes to the liver, and from there to the tissues (e.g. the bone marrow) which are concerned in the formation of new blood. It is well known that our individual blood cells do not have a very long life, and that, therefore, it is necessary constantly to replace them by new ones.

Failure to replace them in sufficient quantity leads to severe anaemia. Absence of the intrinsic factor from the stomach secretion leads to such failure.

Let us consider its structure. The stomach is a muscular bag so arranged that, in addition to receiving food (via the oesophagus) for preparation before entering the intestine, it can mix the food constituents, and allow the gastric enzymes to act effectively on the whole meal. The upper part of the organ is called the fundus, the middle part the body, and the lower part the pylorus. The shape of the stomach, when examined with the X-rays, is rather like that of the letter J. In some people the stomach does not sag very much, in others it sags markedly. The former are called hypersthenic, the latter hyposthenic stomachs. The oesphagus or gullet does not enter the stomach at its extreme upper end, so that there is a certain amount of stomach above the gullet entrance. As food is taken it tends to fill up the lower part of the stomach first, and any air taken in with the food or gases produced by fermentation will rise into the upper part of the organ. Thus we get what is called the stomach gas-bubble, which can easily be detected by the physician when he maps out the stomach outline by percussion. If excessive quantities of gas are swallowed, or are produced in the stomach, the gas-bubble may cause discomfort and even 'heart attacks' —the upper part of the stomach being separated from the heart by little more than the midriff or diaphragm. The stomach is, as has been explained, a muscular bag, and the arrangement of the muscle-fibres is such that food is not only able to be propelled along the intestinal tract but, whilst within the stomach, is well mixed, and subjected to what may be called a milling action. The muscle layers are not equally thick in different parts of the organ. At the pyloric end, i.e. at the part just before it joins the intestine, the wall is thick and strong, and it is here that the contents of the stomach are worked up into a soft consistency.

In the normal stomach, whilst this muscular action is going on, chemical actions are proceeding. These will be considered later. Life can be maintained without digestion taking place in the stomach; although in cases where the stomach has been in great part removed, or where operations have been performed to minimize gastric digestion, there is always a possibility that pernicious anaemia will develop owing to the absence of the intrinsic factor referred to above. We now know that this can be prevented by feeding the necessary amount of the factor required for blood formation. So far as the actual processes of digestion are concerned, they can with comparative effectiveness be carried out by the intestine and its enzymes. What then are the advantages of possessing a stomach? First of all this organ, by virtue of its capacity, allows of a considerable intake of food without causing

a feeling of undue distension; such as the same amount taken straight into the much narrower small intestine would certainly create. As a result of the chemical control of the passage of food from the stomach we obtain an ordered and not too rapid transfer to the intestine.

Absorption from the stomach is negligible, but there is reason to believe that the mechanism of the stomach helps in adjusting the rate at which the tissues obtain the materials necessary for their metabolic activity. In some animals the stomach is divided into chambers having obviously distinct mechanical functions, and even in man there is more than a suggestion of such divisions. A further use of the stomach is to allow time for an adjustment of the temperature of food and drink, bringing it up to, or down to, that of the body. Many people take fluids and even solid food which are very hot or very cold, and their sudden entry into the intestine would either injure the delicate lining of the bowel or by entering the circulation produce serious disturbances throughout the body. The delay in the stomach is of importance also in allowing any swallowed gases to rise into the gas-bubble, and so prevent undue distension of the bowel. The healthy stomach also secretes an acid, hydrochloric acid, in sufficient quantities to act as an efficient antiseptic. This is of interest through its bearing on those diseases, later referred to, in which no hydrochloric acid is produced by the stomach, as a result of which bacterial infection of the organ is common.

GASTRIC SECRETION.

The lining membrane or glandular epithelium of the stomach is especially adapted to produce from the blood flowing to it a fluid called gastric juice. The amount of gastric juice secreted and poured into the stomach in a given time depends upon several factors. A certain amount is produced when appetite is stimulated, just as saliva is produced in similar circumstances. Again, the introduction into the stomach of a solid body will stimulate the sensitive nerve endings in the mucous membrane of the stomach-wall; from there messages or impulses are transmitted to the groups of cells in the medulla, from which the vagus nerve arises, and thence to the delicate glands of the stomach. As a result we get secretion of gastric juices, and in addition contractions of the stomach-wall, because the vagus nerve contains fibres, the messages conveyed through which control the movements of the stomach-muscle. The vagus nerve is the motor nerve of the greater part of the gastro-intestinal tract, and its messages are responsible for the reflex gastric secretion. The glands of the stomach may also be directly provoked into activity. For example, alcohol is a powerful gastric stimulant, and its entry into the stomach is followed by a copious

secretion of gastric juice. Other chemical stimulants of gastric secretion are commonly used in the form of condiments. This also is the explanation of the introduction of bitter drugs into medicines. But the account of these mechanisms of secretion is not the whole story.

The entry of food into the stomach is followed by the liberation, from the glands at the pyloric end of the organ, of a substance called gastrin. This gastrin soon passes into the blood, and thus reaches the glands of the upper part of the stomach (i.e. the fundus), and stimulates them to secrete. Gastrin is thus regarded as of the nature of a hormone, and has, indeed, been called the gastric hormone. There is a cycle exactly similar to this for the stimulation of the action of the pancreas. There are thus four methods of bringing about a secretion of gastric juice, psychic, reflex, chemical, and hormonal.

COMPOSITION OF GASTRIC JUICE.

The gastric juice is a clear, colourless, watery solution of a number of important substances, including inorganic and organic compounds, and enzymes. These bodies are derived from the blood, from the ingredients of which they are elaborated by the action of the gastric glands. They are not present in the blood as such. The principal inorganic constituents of gastric juice, apart from water, are hydrochloric acid, sodium chloride, and traces of potassium, calcium, magnesium, and ammonia salts. Mucus constitutes the bulk of the organic constituents. The enzymes, which, of course, are also organic substances, are pepsin, rennin, and lipase.

When we study the stomach-lining by microscopic methods it becomes obvious that there are marked differences between the various groups of cells. We can class these cells into three groups:

(1) Mucus cells, which seem to be spread over most of the stomach lining. These cells are responsible for the production of mucus, and are particularly active in certain forms of gastritis, especially alcoholic gastritis; in that disorder, the gastric juice becoming of a very slimy consistency, owing to the presence in it of the protein mucin. These mucus cells are also present in the oesophagus or gullet, where their secretion is useful for the smooth transmission of material from the mouth to the stomach. They are relatively scarce at the entrance to the stomach, but become much more abundant in the fundus and pylorus. These mucus cells constitute part of the glands of the stomach, and their secretion enters more or less into the composition of the gastric juice according to circumstances.

(2) The second type of cell, which we find especially in the fundus of the stomach, is called the peptic cell, which contains in its body peculiar

granules. These are called zymogen granules, and are thought to form the precursor or parent substance of pepsin—the enzyme responsible for the partial digestion of protein. These microscopic granules are inactive whilst in the cell, but when liberated during active secretion they form pepsin. Hence they are called pepsinogen, i.e. the producer of pepsin. The word zymogen is used to indicate any such granules as give rise to an active enzyme. We shall meet the word enzyme again when dealing with the pancreas. The cells of the gastric glands are arranged somewhat like a thick-walled tube, with a narrow lumen or central space, and as the cells produce their secretion it is poured into this tube-like central space and passed into the stomach cavity. Dotted about on the outer surface of this tube-like arrangement we find the third variety of cells, the parietal or oxyntic cells.

(3) The oxyntic cells are easily distinguished microscopically from the peptic cells. They contain in their protoplasm fine channels which join up with the inside of the above-mentioned tube, so that their secretion can readily pass into the stomach. These cells produce the hydrochloric acid of the gastric juice. When the stomach cells are stimulated during digestion these various substances, mucus, pepsin, and hydrochloric acid, are secreted into the channels or ducts leading to the stomach cavity, and on mixing with the food produce their various effects.

THE PROGRESS OF A MEAL.

Now let us consider the course of events which follow the introduction of a meal into the stomach. A meal generally consists of carbohydrate (starch, sugar), fat, protein, salts, and, of course, fluid. We will consider seriatim the changes which these undergo.

(1) *Carbohydrate.* Starchy food if kept in the mouth some time is subjected, as we have seen, to the action of ptyalin; but in ordinary circumstances we do not keep our food in the mouth long enough to change very much starch into maltose. Hence most of the starchy food reaches the stomach unchanged, but a good deal of active saliva is carried with it. Can this swallowed saliva continue acting on the starch in the stomach? The answer depends upon the degree of acidity which exists in that organ. In a normal stomach the acidity soon becomes such that the salivary enzyme (ptyalin) is unable to act, and such starch as has entered the stomach must wait for its digestion until it reaches the small intestine, since the stomach does not produce an enzyme which can act on starch.

Starch is taken in the food as bread, potato, rice, etc., and the various processes these substances undergo in being cooked are directed towards making the starch available for the action of the digestive juices.

Examples of this are the liberation of the starch from the envelope in which it exists, in the potato; the aeration and partial breakdown to glucose of the starch in dough, and so on.

Sugar taken into the stomach as such is usually in the form of saccharose, i.e. the sugar of everyday use. The hydrochloric acid of the gastric juice may to some extent hydrolyse saccharose to the simple sugars, glucose and fructose, but the effect is small relative to that which occurs later in the intestine. In spite of the ready solubility of sugar, very little if any is absorbed from the stomach. The stomach is in fact not an organ adapted for absorption. Its function is to bring about certain preliminary digestive changes, and to control the rate of delivery to the absorbing canal, viz. the small intestine.

(2) *Fat.* The infant's stomach produces an enzyme, lipase, which can split fat into its components, glycerine and fatty acid; but it seems improbable that this exists to any extent in the adult stomach, because the gastric juice is much too acid for it. It is understandable that the delicate organism of the child should be provided with this enzyme action in the stomach, because human milk contains nearly 3% of fat, and the sooner it is made ready for absorption the better. But fat undergoes practically no chemical change in the adult stomach.

(3) *Protein.* It is in the digestion of protein that the stomach takes most part. The gastric enzyme pepsin is one of the class known as proteoclastic enzymes, i.e. protein-splitting enzymes. Pepsin has the peculiarity that it acts best in an acid medium, and it is rapidly destroyed by alkali. Here we see an example of the adaptation of the secretory activities of an organ to the internal requirements. When gastric activity is at its highest the oxyntic cells produce hydrochloric acid in such an amount that the simultaneously secreted pepsin is able to act best. Human gastric juice undiluted by fluids contains about 0·3% to 0·4% hydrochloric acid, and is the only secretion in the body which contains this acid. During digestion the acid is diluted by fluids and some of it is held in combination with the products of protein digestion. Pepsin in the favourable conditions produced by the hydrochloric acid acts upon protein and splits it up into simpler compounds. The ordinary proteins taken in our daily food, such as egg-white, cheese, meat, and so on, are insoluble in water, and one of the effects of pepsin is to produce a soluble form from these.

The further effect of peptic digestion is to change the soluble protein into simple compounds, called proteoses and peptones. It has been explained that proteins are composed of chains of amino-acids linked in a special way, and the action of pepsin may be summed up by saying that it splits the protein into shorter chains. The chains of amino-acids thus produced are still too complex for absorption into the blood,

and accordingly they undergo a further splitting in the intestine. The following scheme summarizes the action of pepsin.

Protein
↓
Soluble form of protein
↓
Certain intermediate forms called metaproteins
↙ ↘
Proteoses ⟶ peptones & some polypeptides
(relatively short chains of amino-acids)

The point to be clearly realized is that pepsin does not split proteins further than to polypeptides, and may do this only to a small degree, the major part of the digest being peptones. In the stomachs of the infant and suckling animal, it seems to be important that the principal protein of milk, casein, shall undergo certain changes known as clotting. Casein exists in milk in a soluble form, and the process of clotting changes this to paracasein, which is insoluble, and so we get clots or curds which consist of paracasein with fat enmeshed in it. The remaining fluid of the milk is called whey, and contains lactalbumin, milk sugar, and inorganic compounds. This process is used in the making of cheese and junket, and is easily brought about by adding rennet to milk. Rennet is made by extracting with brine the inner lining of the so-called fourth stomach of the sucking calf. The enzyme responsible for its effect on milk is called rennin. It is probable that this enzyme is produced in the stomach of all sucklings. It is an interesting fact that similar clotting of milk can be brought about by pepsin and trypsin (see below), provided enough calcium salts are available. In the adult, therefore, rennin would be rather superfluous, and it may be that in the infant this enzyme action is utilized until peptic activity becomes properly established. The breaking-up of the milk protein into small clots or curds may be an important aid to smooth digestion; for the curds are more readily kept in the stomach for some time and so allow the delicate gastric digestion to go on for a longer time.

TESTS OF GASTRIC FUNCTION.

The diagnosis of disease is largely a matter of explaining symptoms by structural or functional abnormalities. Putting a name to a series of symptoms is of no help at all unless the name thus given epitomizes a clear concept of what precisely has gone wrong. Perhaps no term conveys less than does that most commonly used word 'indigestion.' Indigestion may mean almost any disturbance associated with uncom-

fortable gastric or intestinal symptoms. A distinguished physician advised his pupils: 'When a man complains of his heart, examine his stomach; but when he complains of his stomach examine his heart.' Indigestion may be complained of as a result of 'causes' which seem remote from the stomach. Sleeplessness, worry, overwork, anaemia, diabetes, and so on may interfere with the general functions and 'indigestion' may dominate the picture. The physician has to make in his mind a composite picture of the symptoms complained of, the results of his physical examination of the patient, the disturbance in function, and the probable or, in some cases, certain structural abnormality. It is difficult to convey to the lay reader exactly how complex is the mental process of diagnosis, and how easy it is for the physician to content himself with an attempt to relieve symptoms. Unfortunately there are still many diseases in which the relief of symptoms is all that the wisest physician can achieve.

We have several objective methods of studying the functions of the stomach.

(1) By means of X-rays we can obtain direct evidence of the outline and movements of the stomach. By introducing into the fasting stomach a meal of gruel to which has been added some barium sulphate, which is opaque to X-rays, we can obtain photographs of its position, shape, movements, and rate of emptying. This method is most important in the diagnosis of ulcers (gastric ulcer), and of cancer of the stomach. If the meal has not completely passed out of the stomach in six hours there is certainly diminished gastric motility; and should some of the meal be left after twelve hours (no food having been taken in the interval) there is certainly obstruction at the pylorus (pyloric obstruction).

Sometimes defects are seen by X-rays in the smooth outline of the stomach, and one can thus recognize the craters of ulcers, as they are called.

Great attention is paid by radiologists to the waves of contraction of the stomach, and to the shape of the wave at the beginning of the duodenum, which is called the duodenal cap. Tumours are at times quickly recognized, but in their early stages they may not show much evidence of their presence. The X-ray report has to be correlated with the clinical findings; and, if the result is unconvincing, the chemical functions of the stomach are also studied.

(2) The chemical functions which are usually studied clinically are the secreting of hydrochloric acid and of pepsin. For this the procedure is somewhat as follows: The patient is kept without food for some twelve hours, and preferably in bed. He is then made to swallow a long narrow rubber tube loaded at one end, so as to provide something for the gullet to grip. This sounds more difficult than it is in practice;

and, if the patient is not unduly excitable, the loaded end is soon in the stomach, and the contents of the organ can be readily drawn up by means of a syringe attached to the other end.

Much information can be obtained from the examination of the contents of the resting stomach. From a normal organ we obtain a small volume of fluid, containing a little mucus, perhaps some few bits of food-residue, and a little hydrochloric acid: there is no marked smell, and the fluid is clear. The skilled observer can very easily detect if anything is wrong, although to say precisely what is wrong requires a good deal of experience. If there is a large amount of fluid in the fasting stomach, if a lot of retained food or bile or blood is present, or if there is an odour of rancid decomposing food or organic acids, conclusions can be drawn which give great help to the physician.

One or two examples will be of interest. Suppose that the patient has had a severe gastric ulcer in the pyloric region of the stomach (i.e. near the exit), and that in the process of healing a good deal of fibrous tissue has formed. This sort of tissue tends to contract, and may lead to pyloric stenosis, i.e. closure or narrowing of the outlet from the stomach. Fortunately this is not a common event, because gastric ulcers are not usually near enough to the pylorus. Pyloric stenosis may, however, result from the swelling of the stomach-wall round an ulcer. The contents of such a stomach are excessive in quantity (unless vomiting is so great that food cannot be taken by the mouth), and there is always a great deal of decomposition and fermentation. Pyloric stenosis is frequently found in cancer of the stomach. In these cases one finds in the stomach-contents evidence of decomposed blood. Of course tests such as these can in severe cases be carried out only in those intervals when the disease is relatively quiescent.

In cases of hyperacidity (i.e. too great an activity of the oxyntic cells), which we find associated with ulcers of the duodenum, the fasting contents of the stomach are much more acid than normal. Having removed the contents of the fasting stomach, and obtained such information as we can, we now wash out the stomach with warm water by introducing the water with the syringe, and then withdrawing it. This is continued until the stomach is judged to be free of fluid and residues. The patient is now given a very thin gruel to drink, and small volumes of its contents are withdrawn from the stomach every fifteen minutes or every half-hour for two or three hours. By analysis we obtain information of the secretory activity of the organ. This procedure is that of the fractional test meal. Each sample removed from the stomach is analysed for the amount of hydrochloric acid it contains, and frequently also for the amount of pepsin. In any conditions the fractional test meal gives information of direct practical importance.

ULCERATION OF THE STOMACH.

In cases of ulceration near the pylorus there is an increased formation of hydrochloric acid, and the test meal is responded to by a long-lasting high acidity of the stomach.

Hyperacidity is a condition suffered by many people, and it is likely that a long continuation of this may lead to ulceration. In the event of a slight injury or some localized infection in the mucous membrane of the stomach, hyperacidity aggravates the injured tissue and will likely enough lead to severe ulceration. But there are certainly other factors involved. For example, there is a curious tendency for several members of the same family to develop stomach ulceration, and it is an interesting fact that, although gastric ulcer is about equally common in males and females, there are three or four times as many cases of duodenal ulcer in men as in women.

There are some investigators of this disease who believe that there is a centre in the brain, injury to which leads to ulceration in the stomach. Others regard the condition as being due to abnormal activity of the sympathetic nerve-fibres supplying the vessels of the stomach wall, thus leading to spasm of the vessels, local anaemia, and greater liability to infections, and thus to local ulceration. When the ulcer is in the stomach we do not obtain very characteristic changes in the secretion of hydrochloric acid, but when it is in the duodenum the high acidity is very marked. Perhaps because of this, duodenal ulcer is much more easily recognized early than is gastric ulcer, since the discomfort is complained of earlier. The sooner we institute treatment, the more favourable is the outlook as regards healing of the ulcer. Discomfort after food, pain in the stomach region, or radiating from the stomach, hunger pains, regurgitation of very acid fluid, vomiting of blood, chronic constipation, and 'tarry' stools (stools containing changed blood from the ulcer) are among the symptoms of ulceration; but frequently the course of the disease is so slow that the patient may not come for advice until the ulceration is far advanced—particularly as generally the appetite is good and there is no loss in body-weight. The danger of neglect is that the ulcer may burrow deeply and perforate, in which case peritonitis ensues, and immediate operation is necessary. Early treatment by proper diet and neutralization of acid will in many cases obviate this. It is not uncommon to find people with hyperacidity taking doses of bicarbonate of soda to relieve the intolerable acidity of the stomach. This should not be done; because, after a short period of relief the stomach is distended with gas and the acidity later becomes more pronounced than ever. If powders are taken without the advice of a doctor let them be powders containing bismuth compounds, magnesia, calcium carbonate, and only relatively little bicarbonate of soda.

GASTRIC CANCER.

Another type of case in the diagnosis of which the fractional test meal is of great value is where there is suspicion of gastric cancer. This terrible disease makes its presence known in many ways, but only if it is detected early can anything be done to help the patient. Many efforts have been made to detect cancer in general by means of blood tests, but no test has established itself as generally reliable.

The possibility of cancer of the stomach should always be thought of in middle-aged or older men who complain of loss of appetite, nausea, a tendency to vomit, and some pain after food, especially if accompanied by loss of weight, weakness, and pallor. Unfortunately, in the early stages, gastric cancer is usually difficult to recognize. Even X-ray investigations may show nothing characteristic. In such early cases the fractional test meal will give very valuable information, because in the great majority of cases of gastric cancer there is, among other results, either great diminution or total absence of hydrochloric acid, i.e. hypochlorhydria or achlorhydria. The absence of the antiseptic action of the acid allows of fermentation and decomposition of food in the stomach, particularly, as is often the case, if there is obstruction to the free passage out of the organ. The stomach contents are frequently foul and contain lactic acid as a result of fermentation. The fractions removed from the stomach contain blood or derivatives of blood, as a result of oozing from the invading tumour, and also a considerable amount of pus cells (leucocytes) resulting from inflammation of the stomach lining. The test meal rarely leaves the diagnosis in doubt. It must, however, be remembered that a small but appreciable percentage of people are congenitally achlorhydric, so that the absence of hydrochloric acid alone is not sufficient to settle the diagnosis.

PERNICIOUS ANAEMIA.

A third important disease in which chemical analysis of the stomach contents is of great assistance is pernicious anaemia. This disease is, as has been explained, due to the failure of formation in the body of certain substances which are essential for stimulating the blood-forming tissues. One feature of pernicious anaemia is that the stomachs of subjects of this malady contain no free hydrochloric acid. This fact may be more strongly expressed by saying that, if hydrochloric acid is found in the stomach of a patient suspected of having pernicious anaemia, it may be taken that this disease is not present. There is nowadays a good deal of evidence that the absence of this acid from the stomach precedes the onset of the blood disease by some years, and it seems that those normal people who are congenitally achlorhydric run

a risk of developing pernicious anaemia later unless treatment is instituted early. The fractional test meal is now a routine procedure in the investigation of any case in which there is question of this disease.

Digestion in the Intestine

Digestion in the intestine, like that in the stomach, is dependent upon enzymes. The intestinal enzymes are rather numerous, and carry digestion much further than do the gastric enzymes. Whilst the lining of the intestine, like that of the stomach, possesses special cells which secrete enzymes, other enzymes reach the intestine through ducts from their place of origin in other glands. It will be simplest first to deal with these accessory organs, viz. the liver and the pancreas.

THE LIVER.

In the section on metabolism the importance of the liver as an organ concerned in the elaboration of glycogen and the maintenance of the blood sugar was stressed; and some account was given of its role in the de-amination of amino-acids and in the desaturation of fatty acids. Reference has also been made to the liver's storage of the substance responsible for the stimulation of the blood-forming organs, and to the relevance of its activity in anaemia. In addition, the liver functions as a detoxicating organ. Toxins are for the most part products of the activity of bacteria, and are probably in many cases of protein nature. These can be broken down to relatively harmless bodies by the liver as long as the liver cells are themselves not severely damaged.

Bile is a complex fluid secreted by the liver, and carried therefrom by means of the smaller bile ducts to the main hepatic (liver) bile duct. Joining the bile ducts outside the liver is the cystic duct, connected with the gall-bladder, which lies under the right lobe of the liver. The cystic and hepatic ducts continue as one large duct, the common bile duct, and enter the middle part of the duodenum into which the bile is passed. The function of the gall-bladder is not yet completely understood. The removal of this organ does not seem to impair normal digestion, and some animals have no gall-bladder at all. When the bile is obtained straight from the liver it is found to be a much more dilute fluid than is bile obtained from the gall-bladder. Liver bile contains rather less than 2% of solids, whilst gall-bladder bile contains about 11%, owing to loss of water during storage. The principal constituents of bile (excluding inorganic salts, mucin, and a complicated alcohol called cholesterol) are certain pigmented substances, which give bile its colour, and bile salts. The bile pigments are called biliverdin (yellow), and bilirubin (orange). Human bile is usually golden

yellow in colour, and if kept exposed to the air it slowly reacts with the atmospheric oxygen, and turns green. The bile pigments are manufactured not only in the liver, but also in any situation where a certain type of cells is present. This system of cells is called the reticulo-endothelial system, and is represented in the liver, the spleen, and other situations. The changes in colour in bruises are due to the transformation of extravasated blood (i.e. blood released from the blood-vessels) into variously coloured pigments by cells of this type. When bile pigments are formed elsewhere than in the liver we must suppose that they are ultimately carried to the liver by the blood, and excreted into the liver bile ducts, and thus reach the intestine. In the liver the breakdown of haemoglobin goes on very actively, and the bile derived from this may reach one and one-quarter pints a day. Bile pigments after passage into the intestine undergo putrefaction, and change into the brown colouring matter of the faeces (stercobilin), and so are excreted from the body. We can thus visualize the chain of events which necessitates the constant replenishment of blood.

Haemoglobin in red blood cells	→	Broken down in reticulo-endothelial system	→	Bile pigments	→	Liver	→	Intestine ↓ Excreted as faecal pigment

JAUNDICE.

When from any cause there is a considerable amount of bile pigment in the blood, a patient is said to suffer from jaundice. Jaundice may arise from any one of a variety of causes. Thus, inflammation of the duodenum may lead to swelling at the opening of the bile duct, and so to obstruction of the free flow of bile into the intestine. A back pressure in the smaller bile passages may thus be produced, and bile be absorbed into the blood. Similar results may occur if a stone blocks the free outflow of bile. Gall-stones seem to be formed as a result of inflammation in the bile passages or gall-bladder. They usually consist of a mixture of lime-salts, germs, and cholesterol. Sometimes gall-stones are formed almost entirely from bile pigment. Diseases of the liver may interfere with the proper excretion of bile into the intestine, and hence lead to jaundice.

THE BILE SALTS.

Other important constituents of bile are the bile-salts. The bitterness of bile is largely due to these salts, and their importance lies: (1) in their power of keeping cholesterol in solution in the bile; (2) in aiding the emulsification (i.e. splitting into very small globules) of ingested fat; and (3) in acting as a sort of co-enzyme for intestinal

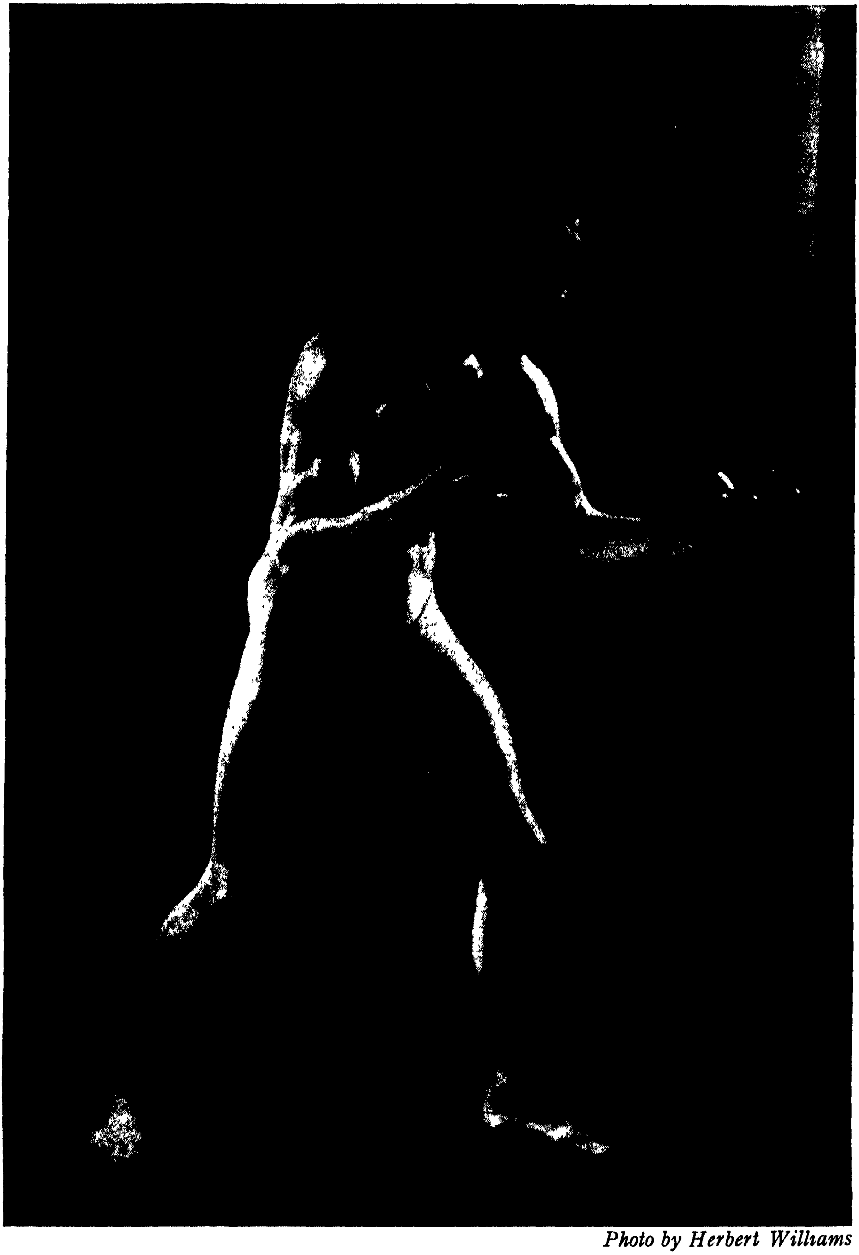


Photo by Herbert Williams

COMPLETELY POISED BALANCE—THE WRESTLER

He can move with equal ease in any direction

lipase, thus aiding in the digestion of fat. The bile salts are called sodium glycocholate and sodium taurocholate, and are complex derivations of cholic acid and glycine and cholic acid and taurine respectively. The bile salts are powerful stimulants of bile secretion in the liver, and are hence called chologogues. After these salts have reached the intestine and performed their various functions, they are re-absorbed into the blood, carried back to the liver, and re-excreted in the bile. This process is called the circulation of the bile salts, and is eminently suitable for meeting the important demands of digestion. Since the bile salts are manufactured in the body, and are not lost by the bowel, it follows that there must be some mechanism by which they are destroyed, otherwise the amount in the body would become impossibly high; but the manner of their destruction is not known. Failure in the body to produce bile salts in adequate amount may lead to formation of cholesterol precipitates in the bile passages, and hence of gall-stone. In cases of jaundice associated with obstruction to the flow of bile, and hence to absence of bile from the intestine, there is a failure in the preparation and absorption of fat. The consequence is that the faeces excreted contain large amounts of undigested fat.

THE PANCREAS.

The pancreas or sweetbread (the Germans call it the abdominal salivary gland) extends across the abdomen from the spleen to the duodenum. It possesses two types of tissue: one producing the internal secretion insulin, and the other manufacturing the complex fluid, pancreatic juice. The former is passed straight into the blood, the latter enters the duodenum by means of the pancreatic ducts. Most active digestion begins in the middle of the duodenum, and continues throughout the small intestine, where absorption into the circulation takes place. This activity is made possible by the richness of pancreatic juice in enzymes which act individually upon the diverse constituents of the food. This is in striking contrast to bile, which is devoid of enzymes. Pancreatic juice is alkaline; whereas gastric juice is very acid. These facts suggest at once that the most favourable conditions for intestinal digestion must be quite other than those suited to gastric digestion. When the acidity of the gastric contents reaches a certain height the muscular pyloric sphincter, which is the muscular ring controlling the opening into the intestine, relaxes and there is a transmission of material into the duodenum. Here the acid mixture meets some bile, with, perhaps, a little pancreatic juice, and its acidity diminishes. A peculiar series of events now occurs. It appears that the mixture thus coming into contact with the duodenal lining extracts from it a hormone-like body called secretin. This secretin has recently been prepared in an almost pure state from the lining membrane of the

intestine of animals. Having been liberated into the duodenum and upper part of the small intestine, the secretin is absorbed into the circulation, probably intimately mixed with the bile salts. The latter, as we have seen, go to the liver, and stimulate its bile-secreting action: whilst the former goes to the pancreas and stimulates its secretion of pancreatic juice. This resembles hormone action, and we may refer to it as the hormonal control of the flow of pancreatic juice.

The pancreas is also under the control of the vagus nerve, but the pancreatic secretion produced by stimulation of this nerve differs in important respects from that produced by the action of secretion. The matter is complex, but we may state the position roughly by saying that the vagus nerve is in control of the secretion of pancreatic enzymes, whilst secretin is concerned with the secretion of water and salts in the pancreatic juice. During digestion both mechanisms are involved, so that we are assured of a duodenal content which is well supplied with enzymes in a medium favourable for their action. The alkalinity of the pancreatic juice is mainly due to the presence in it of bicarbonate of soda, and is such that if mixed with an equal volume of gastric juice it will neutralize its action. The reaction in the duodenum where all these juices mix together is rather alkaline, although occasionally neutral.

PANCREATIC ENZYMES.

These enzymes are divisible into three groups, acting respectively upon carbohydrate, fat, and protein. The last of these, being the most important, will be considered first:

(1) If pancreatic juice (or fresh extracts of the pancreas) be added to protein under properly adjusted conditions it is found to have no effect in breaking down the protein to simpler bodies. But if to the pancreatic juice be added a little of the extract of the lining membrane of the intestine (itself without effect on proteins) the mixture of the two is able to attack and break down the protein. The process appears to be as follows:

The pancreas contains an inactive substance, trypsinogen, which, when provoked to action by the intestinal substance enterokinase, gives rise to an active enzyme or ferment, trypsin. Trypsin can attack proteins only if in a rather alkaline medium, such as is found in the duodenum. Pepsin takes the digestion of protein to the stage of peptone; trypsin takes it to the stage of relatively simple polypeptides. Pepsin cannot act in the duodenum, and trypsin cannot normally act in the stomach, since the reactions are in both cases quite unsuitable. Trypsin cannot break down polypeptides to amino-acids, and, as polypeptides are not suitable for absorption, another enzyme system becomes necessary. This is provided in part by pancreatic erepsin, a mixture of enzymes having the common characteristic of breaking

down polypeptides to amino-acids so that absorption can take place, the protein being reduced to a form in which the tissues can make use of it.

(2) The pancreas resembles the salivary glands in that its secretion contains a powerful starch-digesting enzyme called pancreatic amylase. The medium in the duodenum being slightly alkaline or neutral in reaction, this enzyme can act freely on any unchanged starch which has come through from the stomach. The starchy components of the food are thus here completely changed to maltose, a carbohydrate composed of two blended molecules of glucose. The pancreatic juice contains no ferment which can bring about the final change to glucose. This is reserved for an enzyme, maltase, lower down in the small intestine.

(3) As yet we have not met any very active mechanism dealing with fat. The lipase present in the stomach of the very young animal is apparently not present in the adult stomach. Fat digestion begins properly in the duodenum, and is brought about by pancreatic lipase.

If a man be given a meal containing neutral fats his blood after a time is much richer in fat than before, but the fatty acid is not absorbed as such. After the lipase has broken down the fat, the glycerine and fatty acid have again joined before entering the blood. The course of events seems to be somewhat as follows:

The lipase splits a small amount of fat into glycerine and fatty acid, and is helped in this process by bile salts. The fatty acid now combines with some of the sodium salts available in the duodenum and forms soluble soaps. There are now in the intestine unchanged fat, soap, and bile salts; the fat is broken up into very small globules. When the fat assumes this highly emulsified form it can pass across the intestinal lining into the fine channels called lacteals. These fine vessels all ultimately run into the lymphatic vessels, and discharge into the blood by means of the thoracic duct, which joins the large blood-vessels at the lower part of the neck. Digestion in the duodenum, therefore, carries out these processes. Within it proteins are reduced to polypeptides and amino-acids, starch is changed to maltose, and fat is split and emulsified.

It must be remembered that not all soluble substances are readily absorbed. The intestine exerts selective action, and will in many cases distinguish between bodies which, chemically, are very closely allied. A good example of a soluble salt which is not absorbed is magnesium sulphate (Epsom salts). When this substance is taken, it draws water from the tissues into the intestine, producing tension and consequent aperient action. Sulphates in general are *poorly absorbed, but some* more readily than others. *Thus sodium sulphate (Glauber's salts) acts* as an aperient *in much the same way as Epsom salts, but less effectively.* Although the sugar of everyday use (saccharose) is readily soluble in water, it is not absorbed as such, but is broken down in the small

intestine into two simpler sugars before absorption. The final stages of digestion are gone through in the parts of the small intestine below the duodenum, namely, in the jejunum and ileum, by means of a fluid there secreted called the succus entericus.

SUCCUS ENTERICUS.

This intestinal juice is an alkaline fluid, characterized by the great variety of enzymes it contains. The action of some of these is very complex, and we can only deal with those playing a particularly prominent part in digestion. By means of intestinal erepsin, the digestion of protein amino-acids is completed.

Enzymes for the final digestion of sugars are also provided by this fluid.

Complex Sugar	*Intestinal Enzyme*	*Products of Enzyme Action*
Maltose	Maltase	Glucose
Lactose	Lactase	Glucose and Galactose
Starch	Amylase	Maltose (changed to Glucose by Maltase)
Saccharose	Sucrase	Glucose and Fructose

Digestion of Nucleoproteins

Hitherto we have considered protein as being simply chains of linked amino-acids. But in the nuclei of cells proteins exist in the form of nucleo-proteins, which consist of protein linked to a non-protein body called nucleic acid. Nucleo-proteins exist in foods which are rich in cell nuclei, such as meat, liver, and plants. The nucleo-protein is broken down in the intestine into protein and nucleic acid: the former is dealt with by the usual enzymes; the digestion of nucleic acid is more difficult to follow.

Nucleic acid is the parent substance of uric acid, and its composition is most usefully represented by the following simplified scheme of breakdown of its molecule:

Nucleic acid
↓ by means of an intestinal enzyme—nucleinase
Four nucleotides
↓ by means of an intestinal enzyme—nucleotidase
Four nucleosides + phosphoric acid
↓ by means of an intestinal enzyme—nucleosidase
Purines + a sugar (ribose)
↓
Uric acid→Allantoin

The nucleic acid is finally split into phosphoric acid, a sugar called ribose, and a certain group of compounds called purines, which we must now shortly consider. The purines are compounds of a body called purine ($C_5H_4N_4$). Purine does not exist itself in the pure state but only in the form of amino and oxidation compounds. Uric acid, for example, is a purine compound, its formula being $C_5H_4N_4O_3$, i.e. it is a tri-oxy purine. When nucleic acid is broken down in the intestine, the purines which are liberated are carried to the liver and tissues, and there undergo changes which result, in man, in the formation of uric acid. In dogs, ruminants, and other animals uric acid is further broken down to a substance called allantoin, but in man this does not occur. Uric acid exists normally in the blood and tissues in relatively small amounts, and about half a gram to one and a half grams are excreted daily in the urine. It is very poorly soluble in water, but in the conditions existing in the tissues it is held in solution in small quantities. The tendency to deposit uric acid in various situations is well seen in gout, which is associated with painful swellings around the smaller joints. The reason for restricting the intake of highly nuclear material in this disease is obvious.

In chronic disease of the kidneys there is difficulty in getting rid of the uric acid, and one of the earliest signs that things are going wrong with these organs is an increase in the amount of uric acid in the blood. As for the phosphoric acid and ribose which are left from the break-down of the nucleic acid, they are respectively excreted as phosphate in the urine, and burnt away to carbon dioxide and water.

Final Stages in Digestion

At the distal end of the small intestine, the part called the ileum, the contents are semi-fluid in consistency, yellow in colour, and possessed of a rather penetrating odour. If meat has been eaten we may find some few muscular fibres, but there is no trace of albumin, casein, or connective tissue. A few globules of fat may be present, but only the merest traces of sugar, peptones, or amino-acids. The intestinal enzymes are still recognizable at this point and bacteria begin to appear in great numbers. The cellulose of the diet is absolutely unchanged. During its passage through the small intestine practically everything in the food eaten has been digested and absorbed, with the exception of cellulose, which passes almost unchanged through the human intestine; though enzymes for the breakdown of cellulose are contained in certain fungi, moulds, and bacteria. Ruminants and herbivorous animals are able to digest cellulose, which is changed to soluble carbohydrate and absorbed as such. Of what then does faecal matter consist? Nor-

mally the food contributes little or nothing to the faeces unless a considerable amount of cellulose is eaten, in which case the cellulose appears in the faeces unchanged. The composition of the faeces during starvation is not significantly different from that of faeces excreted on a full diet; in both cases they consist of mucus, bile pigments, shed cells from the intestinal wall, lime and phosphates, fatty substances, dead bacteria, and water. Of the dry weight of faeces bacteria may constitute 50%. From the chemical and microscopical examination of the faeces we may obtain important information about the health of the individual. If blood is present in the faeces, we must decide if it is fresh blood or blood which has undergone considerable changes. In the former case, we may take it that the blood originates from low down in the large intestine or rectum, or that it is due to oozing from haemorrhoids (piles).

The presence of an increased amount of fatty substances in the faeces is always significant. In certain conditions there may appear a very large increase in fatty acids, or a large amount of neutral or unsplit fat. In the former case we may conclude that whilst the lipase of the pancreatic juice is active and is breaking down the fat to glycerine and fatty acid, there is some deficiency in absorption, and this is referable to some defective condition of the intestinal wall, to increased motility of the intestine, or to absence of bile salts or of bile: in the case of faeces very rich in unsplit fat we may conclude that there is failure of pancreatic secretion (lipase) or of both bile and pancreatic secretion. In jaundice, sprue, and a malady of children called coeliac disease, there are marked abnormalities of fat digestion or absorption. When there is obstruction to the flow of bile into the intestine, the faeces show a characteristic greyish or white colour (chalky stools), due to absence of pigment, the odour is foetid, and the reaction is acid owing to the presence of unabsorbed fatty acids. The microscopical and bacteriological investigations give most important information as to the presence of worms, parasites, and bacilli of various diseases. In typhoid fever, dysentery, and cholera, such investigations are most important, and the isolation of certain virulent streptococci from the faeces will often explain symptoms which ordinary methods of inquiry leave obscure. Particularly important is the recognition of tuberculosis of the intestine, which may sometimes be rendered difficult from the fact that the tubercle bacilli may have originated in the lungs and have been swallowed in the sputum.

Evacuation of the Bowel

The importance of regular evacuation of the bowel is obvious, and failure to induce such a regularity is accompanied by all sorts of disorders. The usual evacuation, which, in well-adjusted people, takes place

some little time after breakfast, is brought about by what is called the gastro-colic reflex. This reflex starts in the stomach when food enters it after the night's rest, and travels to the nerves supplying the colon, bringing about a fairly sudden transference of the colonic contents into the rectum. This sensation of sudden fullness is referred to the abdominal wall by another reflex, and may manifest itself as a discomfort or even as a pain. Failure to respond to this by going to stool may after a time lead to a cessation of the effectiveness of the reflex and the constipated habit will become established.

Constipation may, however, arise from disease, in which case the organic cause must be sought; but more frequently it is due to neglect to allow the calls of civilized life to wait upon the calls of nature. When we consider that the faeces are made up largely of bacteria and their products, and that some absorption takes place from the lower bowel, it is clear that we have no cause for surprise when constipation is associated with headache, bad temper, anaemia, poor appetite, and the host of ills which are often readily removed if an aperient is taken, and a regular habit induced. The retention of faeces in the bowel is followed by loss of water from them, and hence subsequent greater difficulty in their expulsion. Haemorrhoids (piles) are frequently associated with constipation, since there is difficulty in maintaining the circulation round the anus if resistant faeces are present, and so the small veins in this situation swell up and may bleed. The efficiency of the child in school is frequently impaired by constipation, and the anaemia we often find in the adolescent girl is quite commonly traceable to a similar cause. Menstruation is frequently more painful than it should be owing to a congested large bowel.

Dietetic measures will often help in constipation which has become chronic. Porridge, wholemeal bread, oatcake, salads, and fresh fruit help to induce regularity. Milk and meat should be diminished for a time. Fluids are helpful between meals. Strong aperients should be avoided if possible; when required, they should be taken only on the advice of a doctor acquainted with the circumstances.

X—DISEASES OF HYPERSENSITIVENESS

THE body reacts in various ways to the attacks of 'foreign' substances. A piece of grit in the eye, for example, produces an inflammatory reaction, including an increase in the blood-supply (as shown by the 'bloodshot' appearance), and the increased outpouring of tears in an effort to wash away the offending substance. Another type of response is also met with in the eye, however, when the merest trace of hay-pollen produces the rapid development of an acute reaction, also characterized by increased blood-supply and increased secretion of tears. This response, however, is not met with in everybody, but only in those who are specially sensitive to hay-pollen. Such sufferers are said to exhibit 'hypersensitiveness,' and the disorder known as 'hay-fever,' in which the nasal passages, as well as the eyes, are afflicted, is one of the group of diseases of hypersensitiveness. This state of exaggerated susceptibility to various foreign substances or even, as will be shown, to physical agents such as sunlight and cold, was first studied in connection with what is known as 'serum sickness.' Briefly the story is as follows: When a person has been given a single dose of some curative serum, say the antitoxic serum used to treat diphtheria, a state of heightened susceptibility to serum develops in about the course of a fortnight. A second dose of serum given after this period, although no larger than the first, and even years afterwards, produces a very alarming response, with the development of a rash and a grave disorder of breathing very like an acute attack of asthma. Even minute doses of serum will produce a severe reaction. If, however, a second dose of serum has been given within a fortnight of the first, this state of increased susceptibility does not arise, and subsequent doses can be given with complete safety. This is the simplest example of hypersensitiveness, the foreign substance in this instance being in all probability some chemical present in the serum which comes from horses. It is impossible to develop a similar state from doses of human serum, since the chemicals then present are those to which the body of the recipient is accustomed. The condition of hypersensitiveness represents in reality the attempt of the body to repel at all costs the foreign invader—and the degree and type of response is frequently extremely unpleasant and even dangerous to the person thus endowed.

Further study has shown that, in man, hypersensitiveness may exist in one of two main forms. On the one hand it may be induced by a single dose of some foreign substance, as described above; or the condition may be present spontaneously, being either inherited or acquired in

some way as yet not altogether understood. Examples of this spontaneous form of increased susceptibility are often spoken of as disorders of allergy, and include asthma, hay-fever, eczema, certain other skin conditions, and possibly some forms of migraine or 'sick headache.'

Certain general points about allergy will first be discussed before brief mention is made of the special disorders described under the heading.

Heredity plays a very important part in the causation of allergy, being present as a factor in 50 to 70% of all cases according to the type of disorder produced. The manifestations differ in different members of a family, and the matter is somewhat complicated by the fact that what appears to be the straightforward inheritance of a tendency to increased susceptibility to certain substances may actually be due to an induced or acquired state of hypersensitiveness brought about through the blood of the mother before the baby was born. However brought about, the allergic state may remain permanently throughout life; although this does not necessarily mean that the various disorders mentioned above cannot be cured. Skin affections may follow direct application to the skin of the offending substance, but more usually result when the exciting agent is taken in through the mouth into the food canal.

It will be seen that disorders of hypersensitiveness of the allergic type depend upon two main factors: the existence of the allergic state in a patient, and the contact of that patient with the exciting substance. The presence of a state of allergy in a patient can be recognized in various ways. There is, for example, frequently a family history of hypersensitiveness; whilst changes in the blood are sometimes found, such as the appearance in greater number than normal of one of the white blood-cells, and there is not uncommonly a very low concentration of acid in the stomach juice. Moreover, it is possible to demonstrate the state of hypersensitiveness to the exciting substance or substances by scratching the skin and introducing minute quantities of various likely chemicals or extracts. In normal people, or with a foreign substance to which hypersensitiveness does not exist in an allergic patient, no very definite change occurs, but round the scratch area of a foreign substance which is the cause of the trouble a large area of redness and swelling appears, the production in miniature of the exaggerated response which is the cause of the particular disorder from which the patient suffers.

Asthma and Hay-Fever

Asthma and hay-fever, already mentioned, are perhaps the best studied of the disorders of hypersensitiveness. The former is characterized by periodic attacks of shortness of breath, due essentially to

spasm of the bronchial tubes and a swelling of the lining membrane of these tubes, causing great difficulty in the expulsion of air from the lungs. Hay-fever occurs at the season of the year when various grasses and plants are pollinating; the sufferer having almost continuously a streaming of the eyes and nose during the eight weeks from the middle of May to the middle of July. Occasionally this state of the eyes and nose continues more or less all through the year, due to hypersensitiveness to some dust other than pollen.

It should be noted that asthma is not quite the simple disorder which has been indicated. Although allergy explains the main symptoms in most instances, there are other factors concerned, such as the chemistry of the blood, the state of the glands of internal secretion, the presence of disease in the lungs, and the mental state of the patient. In connection with the last there is the classical example of the patient sensitive to the pollen of roses who had a severe attack of asthma after sniffing at an artificial flower.

In the treatment of these two conditions the physician has two distinct tasks. There is firstly the cure of the attack, and this can often be effected by certain drugs, especially by the use of the secretion of the suprarenal glands, adrenalin, which relieves the spasm of the bronchial tubes or stops the fluid secretion from the nose. The next step is to prevent further attacks, and here are three lines along which permanent cures can be effected. The patient's allergic state can be altered in some instances, especially on such lines as supplying the acid missing from the stomach juices. Next it is possible by testing the skin (as mentioned above) to determine the exact cause of the disorder. In some instances it is possible for the patient to avoid all contact with this in future, such as when feathers are found to be the cause and the patient substitutes a vegetable stuffing for all pillows, mattress, eiderdown, etc., in his bed. If contact is inevitable, as in the case of hay-fever, where the air is filled with the pollen, it is necessary to proceed to the next step, which is to remove the state of hypersensitivity by the injection of infinitesimal quantities of the offending substance, and gradually increasing these until finally the normal state of resistance is evolved, and the hay-fever sufferer can actually cut the lawn or picnic in the country in complete comfort.

Skin Hypersensitivity

Skin hypersensitivity is responsible for many varieties of eczema. Especially in early childhood eczema is brought about in this way, though the trouble may sometimes be traced to certain elements present in cow's milk, or to eggs. In later life it is not always so easy to find the offending food substance, although meat is sometimes to blame for a

peculiarly itchy type of skin eruption occurring in the folds of the skin at the joints. In all these instances the actual changes in the skin are caused by chemicals brought to the skin through the blood-stream. Another form of hypersensitiveness is where the offending substance is brought in contact with the skin. Certain plants will produce a severe reaction in sensitive persons. In England the *Primula obconica* is the main offender, while in America the poison ivy is the commonest cause. Large areas of the body may be affected a few hours after exposure, and a severe disorder may follow the mere picking of dead leaves. Other substances may also affect the skin and form a group of occupational disorders. Thus bakers may become hypersensitive to flour, doctors and nurses to certain disinfectants, photographers to certain chemicals, and furriers to various dyes used in their trades.

The cure of these skin conditions consists firstly in the treatment of the acute skin changes by local applications, and then the prevention of recurrences on the lines laid down above for asthma and hay-fever.

Urticaria is another type of skin disturbance in which the body becomes covered with itchy wheals which may become blisters. In some instances very intense swelling of the whole or parts of the body may occur, due to actual dropsy or oedema (collection of fluid in the skin and loose tissues under the skin). The commonest causes of this condition are certain foods and drugs. It is well known that susceptible individuals cannot take oysters, shell fish, strawberries, etc., without coming out in a rash. In other cases more common food-stuffs, such as eggs and milk, may be at fault. Certain drugs, especially aspirin, provoke a similar skin reaction, and mental anxiety is also recognized as a factor.

Migraine

Migraine, or sick headache, is coming to be regarded as often a manifestation of the hypersensitive state. The influence of heredity is marked; and a large variety of substances, foods, and dusts have been blamed as exciting factors. Some modern authorities go still further and suggest that the fits of epilepsy may be caused by hypersensitivity, and a similar explanation has been offered for obscure forms of transient paralysis. The evidence is not conclusive.

Hypersensitivity to Physical Agents

Allergy to certain physical agents has been described. Heat and cold and exposure to light have all been blamed for various skin disorders, mostly of the urticarial type. It is thought that these agents cause the liberation in the skin of some chemical to which the patient is

abnormally sensitive. This is also seen in certain rare instances where the skin is so sensitive that light stroking with the blunt end of a pen is followed by the appearance of a wheal along the line of stroking, so that it is possible to write a patient's name, and watch it develop in a living pattern of raised, changed skin.

Hypersensitiveness to various other agents occurs in rare instances which can be briefly listed. Some people have an intense reaction to insect bites, others to sunlight, others to various moulds and fungi, etc. Similarly, various disorders can at times be explained on the basis of hypersensitivity. Some of the manifestations of tuberculosis are thought to be due to this cause, and of recent years the type of rheumatism occurring in children has been explained by some experts as having an allergic basis. There is at the moment a vast amount of research proceeding all over the world on the condition of hypersensitivity and what it really means. The future will probably see many disorders, now obscure, explained on this basis.

XI—SKIN TROUBLES

THE skin must be regarded as an 'organ' with a definite structure, and definite work to do; just as have the other organs in the body, the heart, the lungs, and the brain. It is made up of a continuous inner layer of fibrous tissue through which the blood-vessels and nerves run, and an outer layer, varying in depth in different parts of the body, consisting of several thicknesses of cells, the outermost of which are 'horny.' The inner layer is called the 'dermis,' and the outer layer the 'epidermis.' Dipping down from the epidermis into the dermis are the pockets from which the hairs grow, and close to them are the little collections of small sacs with an opening on to the surface, the 'sebaceous' glands, which manufacture an oily substance to lubricate the hair and the surrounding skin. Other important skin glands are coiled tubes in which the sweat is made, passing up long thin tunnels to the surface. The nails can be regarded as modified portions of the horny layer. The principal work of the skin is to act as a protective covering, to manufacture and get rid of sweat and the oily sebaceous substance mentioned above, to regulate the temperature of the body, and to act as the seat of the sensation of touch.

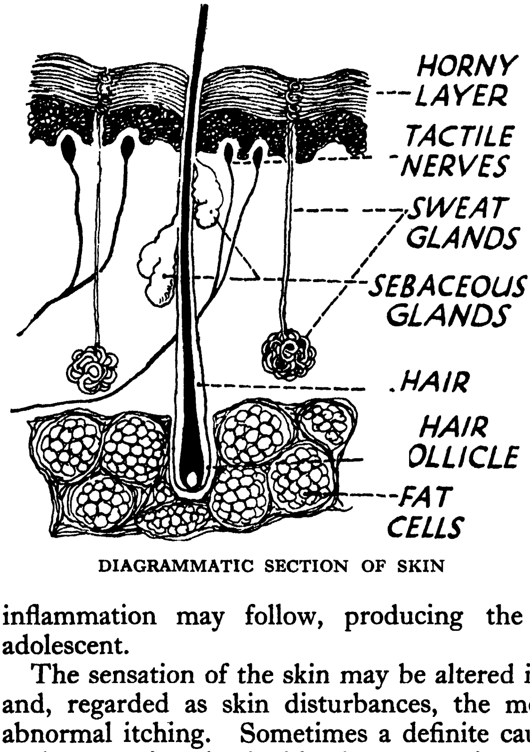
Certain words are used frequently in the description of disorders of the skin, and these must be briefly defined. A macule is a small red spot, not raised above the surface. Larger similar areas constitute erythema. If raised above the surface, a simple red spot is called a papule—larger sizes are called nodules or tumours. If the raised area is white in colour it is the familiar wheal. If small and containing clear fluid it is called a vesicle. Larger sized swellings become blebs or blisters. Where the vesicle contains 'matter' or pus instead of clear fluid it is called a pustule. An ulcer is a localized hole in the skin involving all the superficial layer. A crack in the skin is sometimes called a fissure.

Skin troubles can be dealt with in three main groups: disorders of function (something wrong with the working), inflammation, and new growths or tumours of the skin.

DISORDERS OF FUNCTION

The sweat may be greatly diminished, giving rise to excessive dryness of the skin. This condition is sometimes accompanied by great increase in the thickness of the horny layers of the skin, and is frequently

inherited. There is no real cure, but frequent baths followed by the application of an oily solution may help to supply Nature's deficiencies. Over-activity of the sweat-glands may occur all over the body, or in certain localized areas. The presence of an excess of sweat on the skin favours the growth of certain microbes, and these are responsible for the odour frequently present. The skin in such cases is easily inflamed. Treatment is satisfactory where the disease is localized, and consists principally in putting the sweat-glands partially out of action by X-ray applications.



DIAGRAMMATIC SECTION OF SKIN

Over-activity of the oily glands gives rise to the well-known greasiness of the skin, called 'seborrhoea.' Where the openings of the little glands are blocked 'black-heads' occur, and inflammation may follow, producing the common 'acne' of the adolescent.

The sensation of the skin may be altered in certain nervous diseases and, regarded as skin disturbances, the most important of these is abnormal itching. Sometimes a definite cause can be found for this, such as a poison in the blood or a parasite on the skin, but more often none such can be traced, and these cases must be classed among the functional nervous disorders.

Disorders of the circulation of blood in the skin are responsible for such disturbances as persistent blueness of the hands and feet (perhaps going on to chilblains), eczema, and varicose ulcer of the leg (so-called 'bad legs'); as well as a chronic congestion of the nose and central part of the face, resulting essentially from some form of indigestion.

Inflammation of the Skin

Broadly speaking, this may be divided into two groups: the 'superficial' type of inflammation due mostly to external irritation, and the

'deep' type of inflammation, where the underlying layers of the skin are affected by substances circulating in the blood.

External causes of inflammation may be such things as heat and cold, sunlight, bacteria, or mechanical irritation. The type of inflammation resulting is usually spoken of as 'eczema.' Certain individuals may show an increased susceptibility to irritants, and develop eczema from causes which would not affect normal people. The changes produced in the skin vary with the type of irritant responsible, and especially with the degree and depth of damage present. The situation of eczema also varies with the cause. At first the skin is merely reddened, but areas of small red raised spots soon appear, and these are very itchy. Sometimes the eczema now becomes 'scaly,' that is to say, the superficial horny layers of the skin are recurrently split off and shed. In other instances the skin becomes moistened with a thin, watery material, which tends to 'set' in fine scabs. This is the familiar 'weeping' type of eczema. Sometimes, again, eczema takes the form of a series of small raised vesicles, and this appears frequently on the hands and feet in association with excessive sweating. Continuous scratching may produce secondary changes in eczema, of which a curious thickening of the skin is the commonest. The protective powers of the skin are weakened by inflammation and various microbes may attack eczematous areas, producing more serious types of secondary inflammation with the formation of much matter and thick crusts. The treatment of all the various kinds of eczema (only the chief of which have here been briefly noted) depends upon an exact determination of the cause, so that this can be removed. Measures to allay the inflammation and promote healing are then instituted.

Corns and callosities are really localized responses of the skin to mechanical irritation. The treatment is the removal of injurious pressure, and the cutting or paring away of the hardened horny portion of the skin, after preliminary softening. Scratching may also produce a chronic type of inflammation of the skin, while a well-known form of this trouble is due to injuries self-inflicted by malingerers, where all degrees of slight and serious damage may be done. The nails may be involved in any of these inflammatory processes.

More localized varieties of inflammation of the skin are due to a variety of bacterial agents. Of these boils or the larger areas of similar trouble, called carbuncles, are familiar types, due to a special microbe called the staphylococcus, and often occurring when the general health is below par. Similar invasion of the hair-pockets, in which the roots of the hair are situated, produces a troublesome infection of the area of the beard and moustache, known as sycosis, sometimes, but by no means always, caught in a barber's shop. Another very infectious type of local inflammation is the 'impetigo' of children, with its characteristic

'stuck-on' crusts. Unless carefully and early treated this latter may run through a school or household. Blockage and inflammation of the small sebaceous glands produce the 'acne' of the adolescent boy or girl, another member of this group.

Infection of quite a different type is responsible for another group of skin disorders, namely infestation by parasites. The common flea, the bed-bug, the gnat, and the louse all produce their effect by biting. This gives rise to the small wheals with which we are all familiar, and further damage may be done by scratching. The louse family includes some dangerous parasites. The common 'nits,' which infest the scalp of badly-cared-for children, are the eggs of one variety. The usual effects of the creature's bite are intense itching in the first place, followed by various complications attendant upon scratching and possible invasion by bacteria, as when impetigo develops in the scalp. Scabies or 'itch' is another parasitic disease, in which the parasite burrows under the skin of the hands and other parts of the body, causing a very irritating papular rash. Parasites of the vegetable kingdom are represented by ringworm, due to infection by a fungus. Ringworm of the scalp is almost confined to children, and results in the appearance of a circular scaly area, over which the hair falls out. This is the simple type, but variations occur in which inflammation of a much more severe nature is present; and the same is true when the fungus attacks the region of the beard. Ringworm of the body occurs in various forms, of which the most usual is ring-like, with pale scaly centre and a red spreading edge. This disease may also attack the nails. The treatment of all these parasitic affections of the skin is based upon the use of some means of destroying the invaders, animal or vegetable, and dealing with any damage to the skin. Sulphur ointment is a very satisfactory remedy for scabies, while X-rays are widely used to deal with the troublesome ringworm of the scalp.

Another sort of infection of the skin belongs to the 'deeper' type of inflammation mentioned above. Here, in contrast to the bacterial and parasitic disorders just dealt with, in which invasion occurs from outside, inflammation results from microbes circulating in the blood-stream. The most common example of this is tuberculosis, manifested as lupus. Here a patchy, slowly growing, inflammatory process may, unless checked, produce severe destruction of the skin of the face and adjoining structures. As with other forms of tuberculosis, sunlight, natural or artificial, is of great value in the treatment of that condition.

The remaining members of the 'deep' group of the inflammatory changes of the skin may now be briefly mentioned. It is probable that in them the damage occurs whilst various poisons circulating in the blood are being passed through the skin in an effort to rid the body of them. In this class individual susceptibility plays an important part;

though rashes due to drugs come under this heading, and it is sometimes possible to recognize at a glance which particular drug has caused the trouble. Food rashes are generally of the 'wheal' type; itchy, raised, white patches surrounded by a red area (urticaria). Another member of this group is the localized or generalized reddening of the skin, known as 'erythema'—a sort of blushing of the skin due to various poisons, including the products of microbic activity, as in the rash of scarlet fever, which is essentially of this variety. Another of the 'deep' inflammations is characterized by the occurrence of crops of blisters, which may be the sign of a very serious poisoning of the whole system.

Two scaly eruptions must be mentioned here, although the cause of them is quite unknown, and classification is in consequence difficult. One of these produces a widespread eruption of scaly, flat, red areas, which are usually not itchy, and disappear again after a few weeks (pityriasis rosea). The other has a much more localized distribution, appearing especially on the elbows and knees, and adjacent parts of the limbs, and consists of very scaly patches which often become chronic (psoriasis).

The nervous supply of the skin plays a part in producing certain lesions, of which the well-known 'shingles' is one. Here, after a period of neuralgic pain along the course of a nerve, often round one side of the lower part of the chest, a crop of small blisters appears on a reddened area (herpes). The condition is painful throughout, and difficult to treat.

Skin Tumours

Tumours of the skin are the last group of cutaneous disorders to be discussed. The simplest of these are common warts, which occur in various forms, and may be infectious in origin. Cancerous growths of the skin also occur. Rodent ulcer is one of these, yielding readily to treatment in the early stages, though it may produce terrible damage if neglected. Vascular abnormalities of the skin may be present from birth, and the term 'naevus' is applied to these. They vary from superficial areas of 'port-wine' staining, of all sizes, to areas where deeper layers of the skin are involved, and where the naevus is raised above the surface of the skin. Dark-coloured growths of the skin —usually known as 'moles'—are also usually congenital. All these tumours may, given provocation, grow rapidly. Early treatment is essential, smaller varieties being best cut out, while various forms of destruction, such as carbonic snow, electrolysis, and curettage, are available for some of the others.

XII—TUMOURS

It has been explained that, normally, the various cells of our bodies divide and multiply until the mass thus formed reaches a certain size, which is fairly constant throughout any given species of animal. A man may be four feet or seven feet in height; but we do not find men of eighteen inches or ten feet. So with every kind of animal and, for that matter, with every kind of plant. When a wound heals, the new tissue whereby the gap is repaired grows until the surface-level is reached, and then abruptly stops. Evidently there are within us controlling forces which, according to need, can promote or inhibit the multiplication of any kind of cell. This is the healthy or normal course of affairs. Occasionally, however, for reasons which we do not yet fully understand, certain cells or groups of cells become obedient only to the order to increase and multiply, paying little or no heed to the alternative command to stand at ease. Consequently, an abnormal lump of tissue is formed, having little or no relation to the collective organization of the body. These lumps we call tumours, or neoplasms.

Normally, or, as we say, physiologically, the initial cell or fertilized ovum by the division of which the entire body of each of us has been built up, begins its reproductive activity by dividing into daughter cells apparently similar to itself. At a certain stage of multiplication, however, marked differentiation occurs; so that ultimately are produced groups of cells or tissues strikingly unlike the cells from which they had their origin. This process of differentiation, however, having advanced to a certain point, proceeds no further; muscle-cells dividing to make more muscle-cells, bone-cells to make bone-cells, and so on. From this fact we may infer that the primal germ-cell contains within itself potentialities not only of reproducing its like, but of producing variants at certain stages in its chain of transmission. Usually, such variations subserve the well-being of the whole organism of which the various cells form part; that is to say, they fit in with the general orderly and harmonious scheme. In the process of differentiation, however, certain cells retain a considerable measure of individuality and independence; and it is from these that the germ-cells of the next generation are directly descended. It is a characteristic of the ovum and of the spermatozoon that they contribute nothing to the vital activities of the individual woman or man at whose expense they live. They are not, as the phrase goes, in somatic co-ordination with the other cells of the human body. The mature germ-cell, if unfertilized, passes from the body as dead matter. The fertilized ovum proceeds to develop in the tissues of the

prospective mother as a parasite, deriving nourishment from her blood-stream, pushing aside as it develops whatever structures stand in its way. It has no concern with the well-being of its host, and any elements which it needs it takes, no matter at what price. If sufficient lime for its growing tissues is not present in the mother's blood, it must, perforce, be extracted from her teeth and from her bones. The mother may, if the food supply is scanty, shrink to little more than a skeleton, whilst the growing child within her consumes her substance. These facts have naturally suggested tentative explanations of the perverse activities of cancerous growths. It is presumed that every cell in the body, different though it may be in form and in normal activity from the ovum from which it has descended, yet retains, in however dormant and attenuated a state, rudiments of all the potentialities present in its first parents. It may be that cells differ in their measure of such inheritance; so that, here and there, arises a cell strangely primitive in type; much as happens in human societies. If this be so, one can understand how, given certain conditions and circumstances, sleeping tendencies may awake, and an outburst of 'savage' a-social activity may suddenly disturb the body's peace and harmony. No means have yet been found of distinguishing these potentially malignant cells from the cells that surround them, until they have started on their heterodox career. Nor has research yet revealed the conditions which make for the exercise of their concealed potentiality. Tumours are of various classes, according to the specific kind of cell from which they are descended; according also to certain other characteristics which largely determine their disturbing influence on the general health of the body as a whole.

No tumour, however, plays a useful part in the communal life of the body. It is entirely a-social, even when it is not anti-social. Those neoplasms, usually slow-growing, which consist of cells more or less corresponding with the cells that surround them, and having no tendency to spread to other parts of the body, are collectively spoken of as innocent growths. They are commonly surrounded by a capsule or fibrous shell; and, if they are removed, they have no tendency to recur. Warts are usually small innocent tumours, though occasionally, if subjected to repeated irritation, they become malignant. Perhaps the commonest of innocent tumours are those known as lipomata, which are composed of adipose or fatty tissue. These may occur in almost any part of the body, though they are generally fairly near the surface. Sometimes they attain enormous size. They can, however, usually be easily removed by the surgeon. Of course, a so-called innocent tumour may be a source of great danger if it is in some part of the body inaccessible to the surgeon's knife, and if it interferes with the function of some important organ or other structure.

Cysts

Commonly included among tumours are the various kinds of cysts. These have a somewhat different history and explanation from those of the tumours already described. Essentially, a cyst is a closed sac with fluid or semi-fluid contents. Sometimes, when blood escapes into the tissues, a capsule forms round it, and retains it; thus blood-cysts are formed. The majority of cysts, however, are due to the retention of some natural secretion, such as that of a sebaceous gland, or of the breast, or of a salivary gland in the mouth. Hydatid cysts are capsules enclosing an animal parasite. Other and rarer cysts result from the non-closure of some prenatal tube or cavity, which ordinarily becomes closed before birth. Perhaps the most remarkable of all tumours are the so-called dermoid cysts, which occasionally are found in the ovary, or at the outer side of the eye, or in the neck. These seem to result from the retention of a germ-cell in the tissues of the forming infant. Among their contents may be specimens of almost any tissue in the body—muscle, nerve, bone, hair, nails, or teeth—together with a mass of degenerate cheesy matter.

Naevi

A class of local abnormalities commonly included under the heading of tumours are the so-called angiomata, or blood-tumours. Of these, the commonest are the various kinds of naevus. The simple naevus is merely a collection of dilated capillaries and little veins connected by loose tissue. It is usually present from birth, though it frequently increases in size for some time afterwards. It is, in general, easily cured by electrolysis or, in certain cases, by excision. What is known as a cavernous naevus consists of a number of small spaces or cavities separated by fibrous walls, into which spaces small arteries open so that they form miniature lakes of blood. These are rarely congenital, and are not always remedied with the same ease as are simple naevi. The method of treatment must be left to the surgeon to choose.

Cancer

Malignant tumours include all those forms of neoplasm which are commonly referred to as cancer. Malignant differ from innocent tumours in several ways. In the first place, the cells of which they are composed, though they belong to the same type as do those of the tissue in which they start, have marked differences from any cell actually found in the healthy body. In the second place, these cells multiply with very great rapidity, easily overcoming any attempt made by the

surrounding tissues to enclose them and limit the growth of the developing tumour. Then, again, the cancer cells are not closely attached to one another, so as to form a continuous tissue; they are held together comparatively loosely by fibres, individual cells or groups of cells becoming easily detached from the outer part of the growth. These detached cells are apt to work their way into neighbouring parts, where they soon proliferate and produce new growths in their turn. This, unfortunately, is not the only manner in which cancer is spread from one part of the body to another; for the cells easily pass into the lymph, with which all the cells of the body are bathed, and are then borne away in the lymph vessels to the nearest lymphatic glands as well as into the blood-stream, whereby they are distributed often to parts far removed from the site of the original tumour. But, wherever these fresh growths, or metastases, as they are called, form, the cells of which they are composed are similar, not to the organ or tissue in which they now find themselves, but to the cells of the primary cancer. Thus, if a cancer first develops in the stomach, and offshoots later develop in the liver, these latter are composed of cells not at all like liver cells, but of the type of those found in the stomach. The form of malignant tumour known as sarcoma may, in similar manner, spread from a bone, by means of the blood-stream, to the lung; where the cells of the new growth will bear no resemblance to lung cells, but will be identical with those of the original sarcoma in the bone.

Owing to their rapid and unrestrained growth, cancers tend to destroy the healthy tissues around them—partly by pressure and cutting off their supply of nourishment; partly, apparently, by direct destruction. The central cells of a cancerous growth, being ill-supplied with blood, tend to degenerate and break down; they are then liable to be attacked by bacteria, and the resulting poisons, entering the blood of the patient, bring about a kind of toxaemia, with consequent general debility and ultimate exhaustion. Moreover, the rapid multiplication of cancer cells involves the using up of a large amount of nourishment that would otherwise be available for the normal tissues; this, also, naturally, debilitates the unfortunate patient. When one of the important organs of the body, such as the stomach, or the liver, or the lungs, is invaded by this disease, its functioning is quickly interfered with, with disastrous consequences. A cancer has no nerves, and, consequently, is insensitive, and in itself painless. By pressure on neighbouring parts, or by interfering with the general mechanism of the body, it may, of course, give rise to much pain and discomfort indirectly.

The actual and immediate cause of cancer is not yet known; though it has been found that certain conditions predispose to it. Thus, any form of recurrent irritation, spread over a long period of time, may, in certain individuals, increase what is perhaps a natural tendency in those

individuals to develop cancer in the part that has been irritated—though no sign of this may manifest itself until years after the irritation has ceased. Some chemical substances, including certain derivatives of tar, have especial provocative influence. But there is as yet no general agreement even as to the existence of individual predispositions, or as to the inheritance of such predispositions—if such there be. Nevertheless, a good many facts have been collected. In the first place, cancer never starts in tissues, the cell components of which are not still engaged in reproducing themselves. Nerve-cells, once formed, have no power of multiplication; and cancer never starts in nerve-cells. Then, again, notoriously, cancer is usually a disease of the declining part of life, when cells still multiply, but with diminishing vigour. It rarely begins in youth or in very old age. Another significant fact is that it is, as has been said, particularly liable to start in tissues that have been subjected to repeated injury or irritation which irritation provokes abnormal reproductive and reparative activity in cells well past their prime.

Not unnaturally, seeing how widespread is cancer, and how many other widespread diseases have been traced to a bacterial or virus cause, it has been suspected that malignant disease also has a parasitic origin. But so far no facts have been found to support this supposition, whereas a number of facts seem to negative it. There is no recorded instance of a surgeon or nurse having been infected with cancer, nor can the transference of cancer from one patient to another be shown to have taken place. On the contrary, there are numerous instances of the occurrence of similar cancerous growths in homologous twins, having no direct contact with one another, and living in very different environments. Even chronic irritation by those agents which have been proved to be peculiarly carcinogenic leads to the formation of tumours only in certain individuals among many equally exposed to the sources of irritation. It would seem to be almost certain, therefore, that the ultimate explanation is to be sought in some peculiarities of the internal fluid medium of the body-cells, or in some hitherto undiscovered aberration in the minute anatomy or physiology of the individual cells. The recognition of and avoidance of contact with substances found to be peculiarly provocative, is undoubtedly a progressive step in the direction of prevention. But it seems obvious that nothing truly curative or even truly preventive can be made available until the nature of the structural or physiological aberrancy has been discovered. The difficulties are clearly enormous; but we may confidently say that every year these difficulties are being gradually overcome.

Nearly all the popular 'explanations' have been disproved by careful investigation; and the same, unfortunately, is true of most alleged forms of curative treatment. The surgeon's knife, supplemented in

suitable cases by the use of radium, still offers the only hope of cure whilst our knowledge is as limited as it is at present. Treated early—that is, before the cancer has had time to spread—the results of surgery are far from disheartening. Unfortunately, cancers starting in internal parts of the body, such as the stomach, are usually not recognized until long after their presumed onset. In the short section of this book in which are enumerated certain signs and symptoms which should lead a person to seek skilled advice—that is, to consult a doctor—will be found some of the principal early manifestations indicative of the possible beginnings of malignant cell development.

XIII—THE CHRONIC RHEUMATIC DISEASES

It is said that one-sixth of all the sickness certificates issued by doctors to working men and women in this country give 'rheumatism,' in one or other of its forms, as the disabling cause. It might be presumed that so widespread and so crippling a disorder would, by this time, be well understood, and that suitable means for its alleviation or cure would have been devised. Unfortunately, rheumatism is a term which to the modern physician conveys no very definite meaning. Laymen and doctors alike commonly lump together as rheumatic, all those aches and pains in joints or muscles or nerves for which no other name is ready to hand. It is, indeed, a strange medley of disorders which are thus grouped together.

There is a specific disease which doctors call acute rheumatism, and the public calls rheumatic fever, which seems to be as well defined as is diphtheria or measles. It is a very serious disorder, partly because it is the starting point of a considerable proportion of those diseases of the heart which loom so large in our mortality tables. But there is not the slightest reason to suppose that most of the chronic conditions—sciatica, rheumatoid arthritis, osteo-arthritis, myositis, and so on—commonly classed as rheumatism, are related to this acute disorder either causatively or pathologically.

One of the disadvantages of using a single term to cover a large variety of ailments is that it is likely to lead us to assume that all these ailments are due to some common cause, and that for them all some cure exists, and will ultimately be discovered.

Acute rheumatism is discussed elsewhere in this book. Both the courses and the causes of the many other disorders that pass under the name of rheumatism differ widely from one another. For many years there has been an idea in the minds of most doctors that all sorts of chronic rheumatism have their origin in some septic focus remote from the joint or tissue eventually involved. The idea is not held so strongly to-day as it was a few years ago; but, until recently, it was almost a fashion among doctors to direct nearly every patient complaining of persistent pain in the back or shoulder muscles, or in any of the joints, to have all his teeth extracted, or else to have his tonsils excised. If these somewhat drastic measures proved ineffective, the appendix or the gall-bladder was marked out as victim to the surgeon's knife. But most doctors have lately grown rather sceptical about this solution of the problem. Probably septic foci do frequently play an important

part in lowering the body's resistance to whatever may be the true provocants of rheumatism; but, obviously, it is not the specific cause, or the only cause, of these disorders. Sepsis is not uncommon in the tropics, but rheumatism is very rare there. Also, many of the rheumatic affections are almost confined to those people who use their muscles in excess, and those who hardly use them at all.

Cold and damp are obvious relevant factors; so is clothing, and so is diet. Then, again, certain changes that take place in the endocrine glands, such as the thyroid and the sex glands, at special periods of our lives, often coincide with the starting of rheumatic trouble. There is one form of rheumatism, for example, that is so commonly associated in women with the closing of the child-bearing period of their lives that there can be little doubt that the upset is due to a sudden lessening of the supply of certain endocrine secretions. Other forms of rheumatism so frequently show themselves in joints or muscles that have been subjected to unusual or prolonged overstrain that some causative connection is more than probable. Exposure to cold and damp is so widely believed to be responsible for the exacerbation of rheumatic pain—the value of the rheumatic patient as a weather prophet is well known—that a direct relation between rheumatism and the temperature and functional activity of the skin seems to be established. Much of the success of the treatment at spas is traceable to the means there adopted for the stimulation of the skin and of the surface circulation.

Whatever part is played by infection, by injury, and by glandular inactivity, in provoking the degenerative or functional changes which make themselves known to us by aches and pains, by stiffness and deformities, a certain abnormality of skin activity seems nearly always to be present. This abnormality may be due to inherent peculiarities of the individual, or to the exposure of an average individual to exceptional climatic circumstance.

We do not, as yet, know much about the way in which biologic contact is established between the external forces of nature and the bodily surface exposed to them. It is but a few years ago that we first learned of the profound effects brought about by the ultra-violet rays of sunlight, and we may be quite sure that their recognition is not the last item in the programme of radio discovery. Let us take the one item of temperature. For each person there seems to be a particular range of outside temperature within which bodily health is best maintained. Some of us stand exposure to cold and damp very much better than do others, even though these lead equally active lives. Rheumatism is certainly a disease of damp, cold climates, and is rare in the tropics; and the value of warmth in relieving rheumatic pain, and also in the curative treatment of cases that have not yet advanced to the stage of serious structural change, is universally recognized. There are lots of

people whose skins are, throughout our winter, several degrees colder than are the skins of their neighbours. These are the people who are more likely, given equal provocation, to fall victim to rheumatism. Among these sub-normals, lucky are those who can afford to migrate during the winter months to a warmer and drier climate. The others should surround their skins with an artificial climate, secured by means of sensible clothing and the regulated heat of rooms. But the mention of 'artificial climate' sets one thinking about the possibilities of applied science in this direction, on a wholesale scale. What has been achieved in connection with certain manufacturing processes may be but the starting-point of a physical and engineering revolution, the effect of which on health may well be astounding.

Those subject to rheumatism, therefore, should avoid cold and damp, but do everything possible to improve the skin's reacting power to variations of temperature. A cold sponge-down in a warm room is a good tonic. Constipation should be prevented at all costs. Reasonable physical exercise should be taken, but overstrain avoided. Alcohol is best taken in moderation, or not at all. The diet may be as varied as circumstances permit and tastes dictate.

XIV—BODILY DEFORMITIES AND ORTHOPAEDICS

THE term 'orthopaedic' is derived from two Greek words meaning straight and child, and is not, as many believe, derived from the Latin *pes*, *pedis*, a foot.

'Orthopaedic surgery has for its aim the maintenance of the normal mechanical functions of the trunk and limbs, as well as the correction of such departures from the normal as constitute deformities.'

This is the definition of modern orthopaedics as recognized to-day, and it will be seen that its scope has been enlarged since the original aim, to prevent and to cure the deformities of youth.

The shadow of bodily deformity has been over the world since the earliest times. In the primitive world, the cripple was looked upon as accursed, and being a hindrance to the community at all times, was condemned to banishment or death. A change came, however, with the spread of Grecian culture and, under the influence of the great medical teachers, an opportunity of cure was given to sufferers, especially to the victims of club-foot, which was now widely recognized and treated.

All this enlightenment was lost under the rule of Arabian medicine, and the old savage ideas held sway. The fate of a cripple up to the nineteenth century was either to be branded as feeble-minded or ridiculed as a clown.

But, with the gradual change in the public attitude towards the cripple, came the dark years of the Industrial Revolution. With prosperity came a race of deformed, stunted, pallid children, born under the smoke pall, putting a further responsibility on the medical services of the country. Thus man-made deformity became increasingly prominent, and it remains to-day one of the greater problems of modern civilization.

With these changes in the life of the child came deformities of the adult, which had never been seen before on such a large scale. The factories took their toll of injuries, and there was no organization to deal with them. The credit of recognizing the urgent need for the proper treatment of these artificial causes of deformity belongs to the late Sir Robert Jones. Under his guidance there has been formed a national service for the prompt and efficient care of injuries and deformities of all kinds.

Much of the old attitude to the cripple has disappeared to-day, but still the sinister figure of a hunchback slinks through the dark places

of detective fiction, a remnant of the feeling that a crooked mind is the companion of a crooked body.

The orthopaedic surgeon has under his care the child who has been born deformed, the aged person whose body has been unable to stand the stress of years, and between these limits all the varied deformities and injuries, as well as many diseases of the human frame.

The term orthopaedia, the rearing of straight children, has now a greater significance, the maintenance of that state throughout the years of life.

The actual process of birth is responsible for many nervous troubles that cause deformity. In difficult labour the head of the child is subjected to tremendous pressure by the maternal tissues, and if the brain is bruised the child later shows signs of a paralysis similar to the apoplexy or shock of later life. The muscles of the limbs are in a state of cramp, or increased tension, and by the constant pull on the bones, joints are bent into unnatural positions. The individual nerves may suffer, and an arm, for instance, may be cut off from the nerve centres, leaving a useless palsied limb.

Later in life many deformities are due to the conditions in which we live. The effects of rickets and tuberculosis, which are decreasing, and of injuries in factories, or on the roads, which are becoming increasingly common, form the major part of this group.

Many varieties of deformity are met with in the early years. A mother, after the birth of her child, begins to notice that one of her baby's feet is twisted. The child is brought to the surgeon, and soon, under treatment, the foot is seen growing into the shape of its neighbour.

Later on, a child may be the victim of infantile paralysis, which, after the first acute symptoms have passed, leaves a limb paralysed in one or other of its muscles. Gradually, the leg or arm is restored to usefulness by the aid of careful exercises, or by grafting neighbouring sound muscles to take the place of those paralysed by the poisons of the disease. And so it goes on; at each period of life many such measures can be taken to increase the period of comfort and utility which would otherwise be curtailed.

It is only since the discovery of antiseptic surgery that active operative measures have succeeded in the cure of deformities. The joints of the skeleton are the least fitted by Nature to resist infection by germs. They are specialized to provide stable movements, and this is inconsistent with the power to resist the invasion of disease. As fresh discoveries were made in the field of research, they were applied to this branch of surgery. It was discovered that a piece of bone sawn from its place could survive in another part of the body. New antiseptics aided the fight against infection in the more vulnerable areas of the system. Electrical science provided in the X-ray tube an aid to

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SCOLIOSIS (CURVATURE OF THE SPINE)

diagnosis, and by the use of high-frequency currents, more rapid cure of rheumatic conditions.

Mechanical experts gave their aid in the manufacture of various aids, with the result that to-day we have artificial limbs which are models of anatomical and mechanical perfection.

Before dealing with the various diseases, there are several principles to which reference should be made. Briefly they may be stated thus: permanent deformity results when a part of the body is persistently held in an abnormal position; and, secondly, want of use means wasting, growth and vigour of limbs or trunk being governed by the amount and direction of the forces acting on the part.

The aim of the orthopaedic surgeon is to start treatment at the earliest moment, to keep the muscles, bones, and joints in as normal a position as possible. In order that the growth and health may not be impaired, the affected limb should be used in a normal fashion so far as possible.

A vast equipment is now available to aid the surgeon in fulfilling these conditions. Splints of metal and plaster, appliances of steel and leather, maintain the bones in a position close to normality; whilst muscles and joints are exercised by gymnastic manœuvres and electrical stimulation. Throughout all the treatment cheerfulness of mind is encouraged and fostered; the greatest factor in the success of the treatment being the willing co-operation of the patient.

Developmental Errors

Let us deal briefly with a few of the more important deformities and conditions met with in the course of the surgeon's work, starting with the developmental errors found in childhood. Under this heading there are all the obvious maldevelopments of limbs such as webbed fingers, extra toes and fingers, and occasionally absence of one or more limbs. But there are also more common, yet important conditions, namely, club-foot and congenital dislocation of the hip. In the latter the child, although born with a hip which is out of its socket, shows little sign of its malady until walking commences. In Italy, where the displacement is extremely common, even the peasant women know that their children may be suffering from the malformation, and accordingly bring them for inspection soon after birth. This is, of course, the most favourable moment, and the number of cures is large; the child grows up with a normal hip, and what is even more important, freedom from the habit of bad posture and gait, which results from walking with the hip untreated.

The hip-joint normally consists of a cup-and-ball joint, and for normal shape and function the ball must be constantly moving in its cup-shaped socket, much in the same way as a pestle is ground in a

mortar, or a motor-car valve is ground into its seating. If the child is born with the ball-shaped portion lying free, an unsatisfactory socket results, and a new socket may even be ground out in an abnormal place higher up on the hip-bone, where the ball-shaped thigh-bone has rested.

The first steps in treatment are to place the thigh-bone in its normal position in the socket provided by the hip. If the bones have been separate for some considerable time, a large amount of gristle may lie between, and form an insuperable barrier to replacement of the bone. The muscles of the thigh are shortened, and must be gradually stretched while we are placing the bones in position. The leg is usually placed at right angles to the trunk, a plaster of Paris splint being applied while it is in that position, which has proved more stable than any other. Gradually, stage by stage, the limb is carried down to its normal place, and walking can be started when an X-ray plate shows that the hip-joint is normal.

Sometimes, however, either because of advanced age, or excessive deformity, an operation is necessary to place the ball in a socket carved in the thigh-bone, or make a ledge of bone above the shallow, unsatisfactory socket to deepen it, and so retain the head of the thigh-bone in its normal lower position.

CLUB-FOOT

One of the first deformities to be recognized, and treated, was that known as club-foot. This condition is familiar to the majority of people, though its cause is, as yet, unknown.

The foot is built up on a bony framework, composed of many small bones, square and cylindrical. The former are placed under the ankle joint, and are connected to each other, and to the longer fan-shaped set of toe bones, by joints and sinews. Together, they form two arches, one running from toes to heel, the other from side to side. These arches are braced by sinews and muscles which run from one extremity of the arch to the other on the concave surface. At birth the adult bones are represented by a gristle-like material, a perfect forecast in miniature, later forming the natural bone by a process called ossification. This gristle-like substance, called cartilage, has the texture and resiliency of hard rubber, and with the expenditure of some considerable force, the foot can at this early stage be remodelled by manipulation. Ossification spreads from a central point in the square bones, and from the ends of the cylindrical bones. It is important to remember that the shape of the fully grown bones is exactly the shape of the miniature pieces of cartilage, and treatment must be instituted soon after birth to mould the still pliable foot into natural position, and to allow growth to proceed in normally shaped 'patterns' of cartilage.

The term 'club-foot' covers several types and blends of deformity, the commonest being a combination of two positions. The sole, instead of facing downwards, is turned in, and the muscles of the leg, being short, pull the heel up. There may also be an additional complication, when the foot is bent across the centre of the sole. Other varieties of club-foot are found in which the foot is turned out, the heel pushed down, or only the front of the foot is twisted outwards, or inwards.

The first step is to manipulate the foot as soon after birth as possible, and by constant repetition to endeavour to secure normal relationship between the bones.

This is done twice weekly, splints being applied night and day in the interval. Before walking commences the feet should be equal in size and shape.

If the deformity resists such treatment, this is due to abnormal tightness of the sinews and muscles. They can be divided without injury to function, and will then allow moulding to place the components of the foot in a normal relationship.

If years pass without any attempt at cure on behalf of the cripple having been made, the bones become irregular and misshapen, the sinews and muscles adapt themselves to this abnormal state, and change as a result of their position. Corns and bunions appear on the tender areas of skin, which, although never intended to bear pressure, are subjected to all the weight of the body. There is now no improvement to be hoped for from manipulative treatment, or even from the division of soft tissues. Only a remodelling operation on the bones themselves will suffice to produce a limb normal in shape, and capable of natural, but limited, action, though reduced in size.

Flat-Foot

It is convenient to discuss here a condition which falls into no particular class or group, but is common at all ages, namely, flat-foot. One of the prices of civilization is the covering and cramping of the foot by a leather shoe, whose thick sole checks nearly all the normal movements seen in the feet of the primitive, barefoot races. Consequently, the foot loses its elasticity and muscular power to a varying degree.

The foot is too often believed to consist of an arch of bones depending on its integral form for the maintenance of its shape. In actual fact the curve of the normal foot is held by the muscles of the sole, in the same way as a bow is held by the string attached to the ends. When the muscles, through loss of power, are unable to preserve the bony arch intact, the foot becomes flat. All treatment aims at restoring the muscles, by exercises and massage, to their previous strength.

Two examples will prove this statement: a highly arched foot can be as troublesome as a flat one; and, secondly, the foot of a ballet dancer is flat in repose, but by contraction of the muscles can be made to assume the natural arched position, when walking or dancing.

Rickets

Common to both rural and industrial districts, the cause of rickets has at last been discovered.

It is a disease of babies, caused by the absence of vitamins in the diet, especially of Vitamin D, which is necessary to secure the absorption of lime from the food, and allow its inclusion in the growing bones. If this vitamin is lacking in the food, and the baby is kept in sunless surroundings, little or no lime is absorbed, and the bone is soft and stunted. If food containing this substance, particularly cod-liver oil, is included in the diet, the lime is absorbed and conveyed by the blood-vessels to the sites of active bone-growth, to take its place as the hard supporting material in the framework of soft binding tissues. There is rarely lack of lime in the food, only a failure to absorb it on the part of the body.

If the child walks while the bones are still soft they will bend under the weight of the body, and bow-legs result. The deformity will be perpetuated if the bones then become hard by the laying down of lime.

If the child is seen while the bones are bowed, but still soft, long, straight splints are applied to the inside of the legs, and by bandaging leg and splint, a normal, straight leg is secured.

But if the limbs are bowed and the bones hard, the curve is straightened by the removal of a wedge of bone from the point of greatest curvature. Splints are then applied, and the bones unite, as in the healing of a fracture, by an investment of new bone. Liberal use is made of the aids of sunlight, good vitamin-containing food, and fresh air to prevent any further deformity by a recurrence of the disease.

Surgical Tuberculosis

Tuberculosis also is, unfortunately, prevalent in childhood; and its bone and joint manifestations often come under the care of orthopaedic surgeons. The parts affected are numerous, no bone being immune, and as the progress may be insidious many arrive for treatment at a late stage in the disease.

The story is much the same in most cases. A trivial injury causes the development of a small area of unhealthy or dead tissue in the joint or bone. Tubercle bacilli, which happen to be sweeping through the

By courtesy of Dr. A. MacGowan

CONGENITAL DISLOCATION OF RIGHT HIP

Before treatment in child too old for manipulation: the lower photograph

blood-vessels, having entered the body, through tonsil, lung, or intestine, settle in this area immune from attack and steadily multiply. Once a hold is gained they gradually destroy the tissues around, by use of their poisons, until a cavity appears in the bone, and if unchecked, the joint soon becomes a structureless mass of dead flesh—indeed if not checked the disease may soon become a generalized infection resulting in death.

In the early stages Nature's effort to cure can be assisted by good, nourishing food, and by resting the joint in plaster of Paris, splints, or supports.

If the disease has been checked at a later stage, when the bones are destroyed in part, fresh bone can be inserted to strengthen the affected areas. When placed in position these 'bone grafts' bridge the dangerous weak area by a span of strong bone and shield it from further stress and injury.

The methods adopted to secure healing are exemplified in the treatment of tuberculosis affecting the spine.

The spine is built up of cylinders of bone—vertebrae—resembling a string of beads, the spinal cord passing from the brain downwards like the thread. Each bony segment is connected to its neighbour, above and below, by joints, ligaments, and the large muscles of the back. The disease starts in the bone, and eats away the substance, until only a shell is left, liable to collapse with any sudden strain of the back. Large abscesses may form, with resulting damage to the spinal cord, and paralysis of the muscles of the lower limbs. If untreated the disease may be fatal, if cure occurs at a late stage of bone destruction one variety of hunchback may be the result, as the back is acutely bent at the place of spinal collapse.

The earliest indications of the trouble are often very slight, an aching or stiffness of the back when fatigued being the only sign of the ravages of the disease internally.

The factors for successful curative treatment are absolute rest for the spine; the prevention of deformity; the avoidance of pressure on nerves or spinal cord by prompt treatment of any complications; and building-up the general health by the use of sunlight, open air, and nourishing food.

Accordingly, these cases are best treated in open-air hospitals, where the patient can lie in a long splint of canvas and metal, or a plaster of Paris shell moulded to the shape of his body.

Abscesses, if present, are opened and, later, bone grafts inserted to form an efficient internal splint, and support to the diseased bones.

Efficient after-care is urgently required when these people return to their homes, which, in many cases, are poorly adapted to the maintenance of healthy life.

Fractures

The treatment of broken bones has been reviewed in the light of lessons learnt in the Great War. Early setting of the bones and perfect rest while they are uniting are essential. Large centres dealing solely with this branch of surgery are now common, mainly on the Continent, where insurance companies unite with surgeons to ensure the prompt return of an injured workman to employment. The diagnosis of a fracture is now aided by the X-ray tube, and the treatment constantly controlled by frequent X-ray photographs of the bones as they lie in the splint.

It may help us to appreciate the difficulty of setting broken bones if we place two pieces of wood, to represent a broken bone, in the centre of a large pad of cotton-wool, to represent the muscular covering, and then attempt to place the sticks end to end in perfect position. The difficulty is increased when elastic muscle is substituted for the wool, for we have then to deal with the pull and interplay of the many forces acting on the bones.

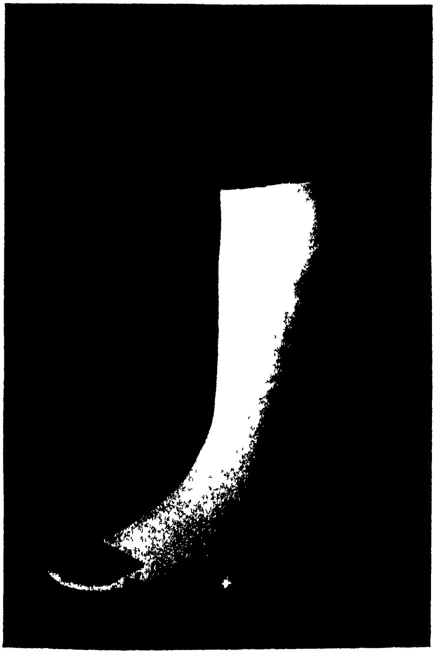
Once the bones are placed in proper position, always remembering the natural curves present in long bones, the process of healing starts. This process is easier to understand if a plumber's joint in a lead pipe is visualized. Blood flows from the ends of the bone, and soon the broken ends are surrounded by a mass of congealed blood. Gradually lime is added, brought by the blood-stream, and it becomes, by degrees, a replica of the tapering joint of lead applied to the pipe. In the course of two or three months the joint is firmly cemented by a covering of hard bone.

The commonest fracture is probably the so-called Colles's fracture of the wrist, named after the surgeon who first described it.

The situation is at the lower end of one of the forearm bones—the radius—just above the wrist joint. A heavy fall on the hand causes the bone to snap, the wrist and hand being bent backwards in the shape of a dinner fork.

After setting the parts in their natural relationship by manipulation, a sheet of muslin impregnated with plaster of Paris is applied to the arm to hold this position undisturbed for several weeks. After a short course of massage, with the removal of the splint, the arm is freely used in the ordinary way.

At the other end of the scale there are fractures of the thigh bone, which introduce problems of a totally different nature. Here is a long bone of small diameter, covered by the largest muscles of the body, each exerting its action on the bone, and tending to pull the broken ends past each other. This difficulty is overcome by placing the limb in a long



Above:

FRACTURE OF THUMB

Before and After Treatment

Below:

PLASTER SPLINT ON LEG (FOR FRACTURE)

By courtesy of Dr. A. MacGowan

skeleton splint, consisting of an upper ring and two long side-bars of iron, with flannel slings to support the leg. A steel pin inserted through the lower part of the bone will, when a suitable weight is attached to it, neutralize the pull of the muscles, and allow strong union to proceed unhampered.

The patient, however, cannot put his full weight on the limb after his six weeks in this splint, as the joining medium is still soft bone. He accordingly wears a special walking splint, in which his weight is transmitted direct from hip bone to both heels by twin steel bars, and the muscles of the body are consequently kept firm and strong by active exercise.

The principles involved in dealing with injury to the fleshy tissues of the body are all exemplified in the treatment of the familiar sprained ankle. The pain and swelling in the ankle, after a violent twist, is a sensation experienced by nearly all at some time.

With the twist one or more of the ligaments of the ankle is torn from its anchorage in the bone. Blood escapes around from blood-vessels in the neighbourhood, and the ankle becomes swollen and painful. Our first consideration is to disperse this swelling by the even pressure of soft bandages. As the ligament is only secondary to the surrounding muscles as a support of the joint, the ankle can be kept moving, and thus no harmful adhesions which would cause pain later are formed.

If adhesions have been allowed to form they must be broken down by manipulation and massage.

These principles are kept in mind in all such strains. The cases of 'misplaced bones in the back,' which are 'replaced' by the manipulations of the unqualified practitioner, are in reality cases of strain of the muscles of the back with the development of adhesions, which, under his hands, snap as they are torn apart.

An injury of great interest, because of its frequent occurrence in sport, is the tearing or displacement of one of the cartilages of the knee joint. These two small pieces of hard gristle are semicircular in shape, and lie at the circumference of the knee between the bones, forming a rough circle. A sudden twist of the leg, common in swerves of the football field, may tear one from its moorings, and as it lies jammed between the joint surfaces, the knee is fixed until it is forced out by manipulation or removed by operation.

The removal of one or both of these bodies is without ill effect, as they only serve to fill in the waste space between the shin and thigh bones in the joint. In some of the lower animals a complete circular disk represents the remnants left in the human knee.

Arthritis

In adult life there are several joint diseases collectively called rheumatism, which afflict an enormous number, and cost the nation millions of pounds every year. The two most important varieties are rheumatoid arthritis and osteo-arthritis, the former affecting the coverings of the bones of the joints, and the latter the actual bony parts themselves.

Rheumatoid arthritis usually affects many places simultaneously or successively. Attacking all ages from twenty upwards, it gradually causes stiffness of the limbs by contracting the coverings of the joints unless it is promptly checked in its early course.

Osteo-arthritis, on the other hand, is mainly a disease of later years, confining itself to one joint. It may be regarded as an indication of the wear and tear of the years on the body framework, whose restorative powers are unable to cope with the stresses imposed on it.

Muscles and Fibrous Tissue

The circulation of healthy blood is necessary for the nourishment of muscles. But the contractile and elastic red 'flesh' is only part of the muscular system. Each long muscle has a 'business' end, where its force is applied by means of a fine tendon upon a definite bony *point d'appui*, and an origin which may be fan-shaped and attached, not only to bones, but to great bands of non-contractile 'connective' tissue, which may be the origin of many other muscles. Particularly at the end of origin there is a zone where muscle and fibrous tissues are blended inextricably, and even in the least 'fibrous' part of a muscle there is a considerable amount of necessary connective tissue acting as framework and sheath. The flatter muscles of the trunk assume almost any shape and, particularly in the chest wall, are 'dovetailed' into one another. From their nature, connective and fibrous tissue structures cannot have the same advantages in the way of blood-supply as have muscles and vascular organs. They depend mainly upon slow percolation of lymph and serous fluid for their nutriment and lubrication. Compared with the flow of blood in the muscles the fluid in fibrous tissue is stagnant. Impurities are slow to be dispersed. If the plasma is not healthy, if germs and their effluents enter a fibrous area, the part is much more likely to become inflamed; certain areas become dry from interference with their normal supply of lubricant, and then adhesions are quick to form and slow to go. Fibrositis is a general term for inflammation of this kind. As nerves, blood-vessels, lymph channels, and muscles are interfered with as they pass through an inflamed and hardened area, it may be understood that not only may a great deal of local pain be caused, but that discomfort over wide regions may be the

result of this—again often avoidable—condition. By careful assurance that each muscle is working easily both by itself and in relation to its neighbours, and by following some of the advice given previously, fibrositis and its crippling effects can be practically banished from our bodies.

LUMBAGO.

Lumbago, one of the commonest of disorders, causing, when severe, complete inability to perform any physical work for seven to ten days, may be chosen as a typical example of fibrositis—though some maintain that the condition is more commonly due to rupture of real muscle-fibres. From the common history of most acute attacks this opinion seems untenable. The attack begins something like this: The body is, let us say, in a stooping position, unsupported by the hands; the effort to rise erect is made carelessly, the mind being occupied by other things; a sudden sensation of inability to complete the movement, and a violent tearing pain in the back, occur almost simultaneously; the sufferer grasps at the nearest support and remains half-bent, and after a moment or two may be able to push himself erect, but each subsequent attempt to stoop and straighten is attended by such pain that the back is kept fixed as in a vice by spasm of protecting muscles; walking is carried out with difficulty, the body leaning forward from the hips; the face shows anxiety, for each unsupported movement is accompanied by a jerk of the irritated muscles of the back with a return of stabbing pain. Once it is contracted, lumbago is extremely likely to return. If attacks occur frequently, a permanent stiffness may develop, which curtails the mobility of an active man to a very inconvenient extent.

As lumbago is such a common ailment, and an excellent example of a crippling malady which can be much alleviated and prevented by special exercises, its prevention and cure may conveniently be described here. Incorrect habitual postures—sitting too long with the hips tilted or the body twisted, or the whole back rounded without sufficient support for the relaxed muscles—are the main causes of attacks of lumbago. Another frequent provocant is an attempt to perform some piece of work or sharp movement when the back-muscles are out of condition —for example, after an illness. The 'old-fashioned' erect sitting position insisted upon in the Victorian era, provided that the support fits the natural curves of the figure, is the correct one. Modern conditions provide plenty of aids to lumbago. Hardly any car manufacturers, for instance, make the driver's seat correctly. The usual driving attitude, made even worse by the necessity of the constant use of the right foot and leg for the accelerator, is one of the worst offenders among many avoidable causes. Extra large people at theatres or picture-houses adopt peculiar attitudes for comfort or to avoid

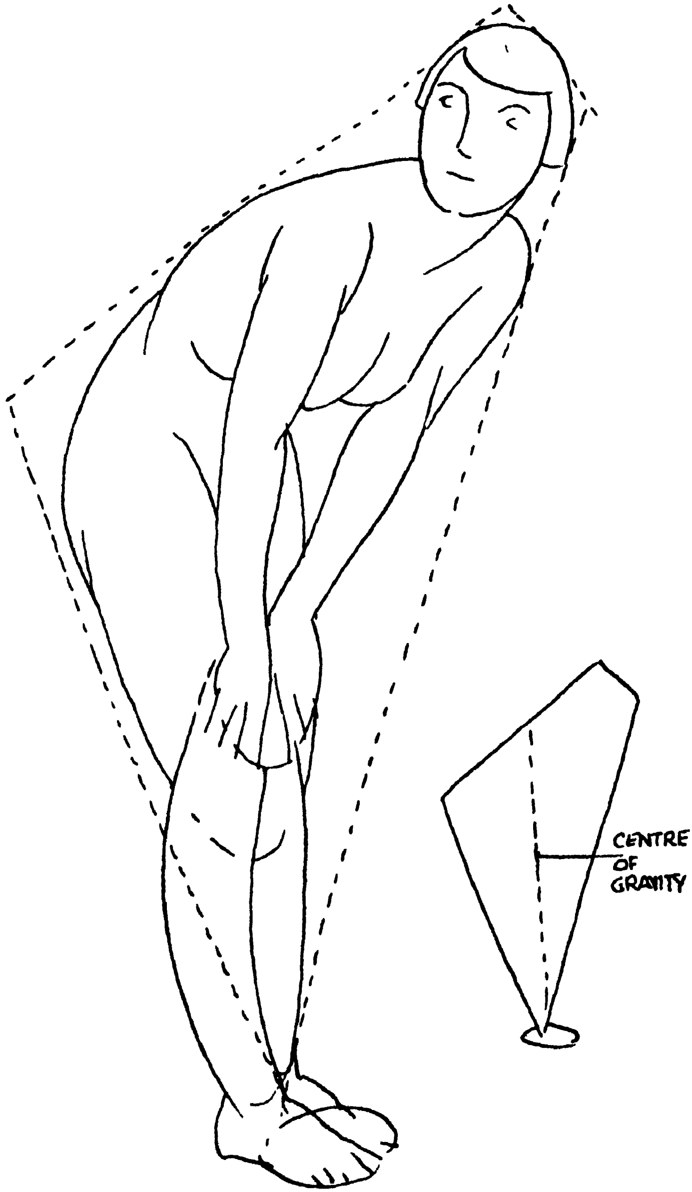
inconveniencing their neighbours, and do not readily notice stiffness and discomfort, as their attention is absorbed by the entertainment. A cold draught also precipitates muscular stiffness. The car driver should use a small cushion, which must be placed so that it completely supports the small of the back: a cushion which takes the correct shape and keeps it is the best. Any stiffness should be prevented by frequent forced stretchings, and extra precautions must be taken if any of the factors previously described are known to be present. And, above all, if the liability to lumbago is known, the following exercise, which was devised by Dr. E. F. Cyriax, and described by him a few years ago in the *British Medical Journal*, should be regularly performed. As soon as possible after an acute attack of lumbago has set in, the sufferer should get, or be assisted, out of bed, and place himself astride of a chair which has a back of convenient height, resting his folded arms on the back of the chair. It will be found that the whole weight of the body can be taken by the arms and shoulders, in such a manner that the rest of the body, particularly the injured back-muscles, may be completely relaxed. A friend of the sufferer must co-operate sensibly in the performance. While taking all his weight on his arms: (1) the patient bows down his head and gradually bends his body down—down—until it will go no further; (2) then the assistant places the flat of one hand on the small of the back, and gives support by a steady push, as the patient gradually levers himself absolutely erect by help of his arms, the hollow of the back still held firm and emphasized by the helper. At this stage a pause is made while the assistant deeply kneads the spinal muscles with his thumbs in an outward direction, as if he were separating them from the central ridge: usually a hardened and tender area will be discovered, which merits special attention; (3) the patient twists his body, still in the erect position, and without turning the hips, as far as he can to the right, while he continues to relieve his back of all weight, and his assistant firmly supports the hips with both hands, and then returns to the central position. Then movements (1) and (2) are repeated, followed by movement (3)—but to the left this time. Down, up, twist to the right, back to the centre; down, up, twist to the left, back to the centre—repeat, even with groans, for about ten minutes. It will be found that wonderfully little pain is undergone when this exercise is correctly performed, as the painful area is stretched and straightened while it is relieved of all strain: the deep kneading of the relaxed spinal muscles, while the back is hollow, painlessly (almost!) breaks down adhesions which are beginning to form, and the stretching of both sides together and separately, without the fear of that agonizing spasm, renders the inflamed tissues pliable once more. Even after the first 'treatment,' it is amusing to see the sudden abortion of the contemplated groan, as the sufferer is invited to rise from the chair!

Naturally, the pain and stiffness may return to some extent in the intervals between exercises, but these latter should be carried out several times daily. If extreme difficulty is experienced in getting out of bed, or if it is not deemed advisable, the treatment can easily be modified for carrying out without rising. When done for prevention, the performance of the exercise is quite beneficial without the massage or help of the assistant. Another useful manœuvre which often banishes slight stiffness and 'disproves' warnings of an impending attack of lumbago is to submit the whole spinal column and its attachments to sharp repeated 'jars'; this can be done by stiffening the whole body in an erect position, springing up a short distance and landing sharply on the heels: an exercise more for the 'active' type, this, and rather alarming for those in the flat below!

General Plan and Aim of Physical Exercises—Cultural and Remedial

The study of muscle-control must be preceded and accompanied by the acquirement of the power of relaxation. The meaning of relaxation is easily explained, but not so easily is relaxation taught. Think of the conditions required for unconscious relaxation: complete comfort, or sufficient blunting of the perception of discomfort by intense weariness or drugs. A corollary of this statement is obvious: that the products of fatigue are of a stupefying nature. We cannot wake refreshed from sleep if we have allowed the products of fatigue to accumulate to excess. Deep breathing helps to disperse these poisons, so that we must keep our lungs in condition for absorbing as much oxygen as possible, by practising this exercise. Perform your home-exercises in the open air, or with the bathroom window (which should be of ample size) wide open. When you awaken in the morning practise relaxing your body, beginning with the facial muscles; 'flap' your hands at the hinge of the wrists until you are sure no muscle is impeding the full movement; see if you can 'drop,' not 'put,' your arm to your side, and let it swing from the shoulder as a pendulum in a clock. Thus the difficult power of voluntary relaxation may be self-taught, and perhaps much of a doctor's time saved at some examination. (Relaxation is probably the most difficult thing to obtain by a doctor from his patients, and is essential for the success of certain diagnosis.) If any part is difficult to relax, find in what position it can be done most easily. Once the brain has perceived what might be called 'the trick of it,' only occasional reassurance as to the control of this faculty is necessary.

To test every muscle and joint, and produce general ease and grace of movement, is the object of a set of home-exercises. In addition,



BALANCE IN THE FORWARD BEND

Photo by Herbert Williams

BALANCE IN THE FORWARD BEND

Note shoulder girdle and pelvic girdle well shown

attention must be paid to 'weak spots.' Do not forget the action of joints: for instance, the rotatory (circular) movements of the hip, shoulder, hand, and foot, which, properly performed, bring groups of muscles into action in turn, and alleviate the overworking of the muscles of simple flexion, which is likely to happen in the upper arm if the exerciser only studies the size of his biceps muscle. Watch the action of the muscles: the biceps, for instance, is really more important as a supinator of the forearm than as a flexor of the elbow joint, and is at its full contraction when the arm is forcibly flexed and the palm of the hand is facing the shoulder; if the forearm is turned so that the palm turns away from the shoulder the biceps loses its prominence.

Leave deep breathing to definite deep-breathing exercises. Inhale slowly and forcibly through the nose, exhale through the mouth. If you have to breathe quickly there is no harm in breathing through the mouth.

Concentrate on good balance and perfect position by watching yourself in the mirror. Keep your face straight as a beginning. Do not force yourself on. The number of times that the detailed exercises, which are recommended at the end of this chapter, are performed should be gradually increased until the correct limit for your age is reached. It is a good plan to do a few free movements at bedtime: extra-tired muscle-groups are noticed: hopping a few times on each foot alternately—well on the toes, and with the knees at various degrees of flexion (which is one of the final exercises for 'weak arches'), is valuable, and double-hopping with alternate swinging outwards of the legs in a dancing manner is another good evening exercise. The routine exercises should be mainly done in the morning before the bath.

REMEDIAL EXERCISES FOR FLAT-FOOT.

The sufferer from flat-foot should not depend entirely upon clumsy foot-supports. If correct exercises and precautionary actions are performed, these can be discarded in a few months with impunity: if complete reliance is placed on supports the feet will merely splay out more, particularly if the footwear is not firm. Nowadays sensibly built boots and shoes incorporate soles shaped to the correct arches of the feet, and fittings are made to individual cases: this method of obtaining foot-comfort is much superior to any other. Complete control must first be re-established over the movements of the great toes—if it has been lost. While standing with the feet slightly turned in and a few inches apart, raise both big toes to a right angle from the floor, and repeat this several times. Then, keeping the feet tense, allow the weight gradually to come on the front part of the foot, watching the arches the while. If the feet 'give,' the only safe exercise is to practise walking on the outside of the feet with the toes pointing inwards.

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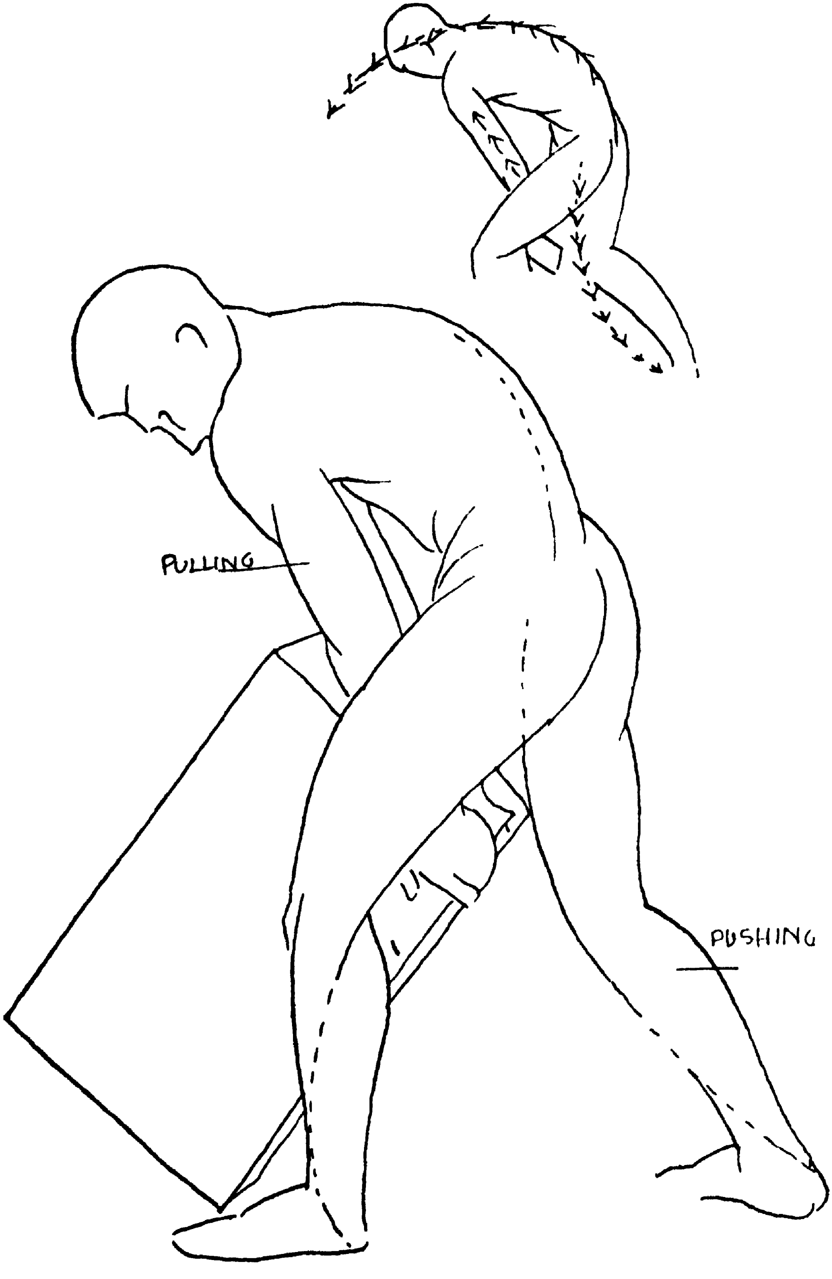


PULLING AND PUSHING

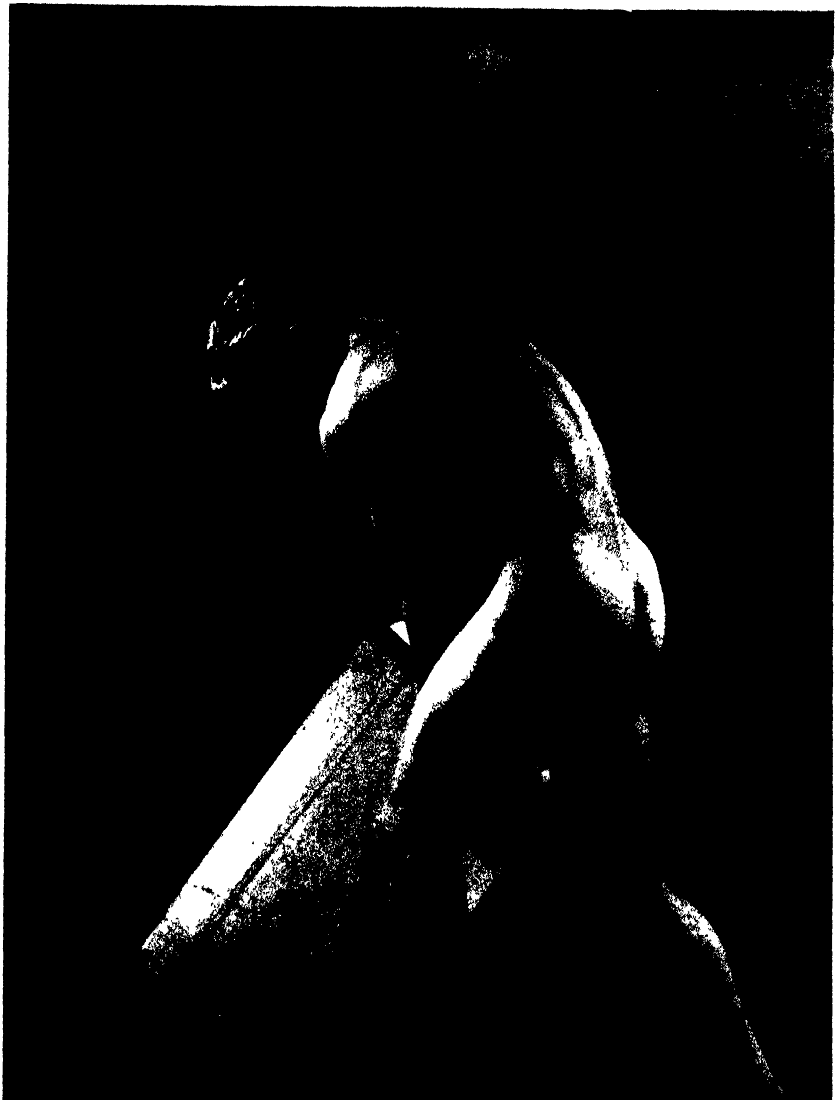


Photo by Herbert Williams

THE PUSHING LIFT

Force acting two ways

As the arches strengthen it will be possible to rise on the toes without the weak 'give'; control will return, and further weight can be put on the feet by practising rising on the toes of one foot at a time. When the final exercise of hopping repeatedly on one foot, the weight coming sharply on to the fore part of the sole, can be done without experiencing any giving of the instep, the fault is cured. But the precautions detailed in a previous paragraph must continue to be taken, and the final exercises incorporated in 'the daily dozen.' If the feet tend to become tired when walking any distance, a valuable plan is to walk for a while as if one were 'gripping the ground' with the feet, thus overcoming the loss of control which has occurred.

CORRECT POSITION OF ATTENTION.

The correct position of attention must be carefully copied from a good illustration. The beginner may imagine that he has adopted a perfect attitude until he views himself from the side by means of a double-mirror arrangement. Many receive somewhat of a shock when they study themselves from this angle for the first time. Stand evenly on the feet, which should be with heels lightly touching and toes pointing slightly outwards—at an angle of rather less than 45° (half a right angle): the knees must be braced back slightly—not at all forcibly—the body is erect, the stomach drawn in, the chest kept naturally emphasized by the position of the shoulders, which are drawn back easily so that the arms fall into the correct position at the sides with the back of the hands outwards and thumbs in line with the seam of the trousers (or just touching the prominence of the great thigh-bone). The head is erect, tilted neither back nor forward, and the neck braced very slightly back to blend with the shoulder position. If the position of the head, neck, and shoulders is granted as the key to the proper position of the rest of the body, the assumption of the whole body-posture is simplified. A strained position, with chin indrawn, bursting chest, protruding 'behind,' and exaggerated lumbar curve with backward sagging of the thighs, is worse than just a wrong position: yet this ugly sight is often seen in pictures of soldiers on parade, particularly in the case of young and keen N.C.O.s on the left of the front rank in inspections. One cannot help calling to mind the marvellous poise of certain sergeant-majors of the army, whose bodies seemed perpetually moulded to come to correct 'attention' at a second's notice. No man can possibly keep up a really strained position for any length of time, whereas the correct posture can be held almost without effort.

HEAD AND NECK EXERCISES.

Once noticed, faulty positions of head or shoulders may be as good as cured, if the habit has not produced real deformity. All that is

necessary in some cases is conscientious performance of exercises such as No. 2 described on page 216. Head-turning and neck-exercises as an addition to any set of exercises will prove worth while. Apart from self-correction, morning headaches may often be cured by free mobilization of the joints and muscles at the base of the skull. As explained above, fibrositis indirectly affects blood-vessels and nerves; the bunch of muscle at the nape of the neck is a common site of this complaint, and pain of a severity from dull to agonizing may be the result. Forward bending movement, followed by complete side twisting with the chin held in different positions in order to ensure stretching of all the muscle-fibres, coupled with gentle massage, confers amazing results even in severe cases where hard fibrous lumps can be felt in the muscles. Mild degrees of joint stiffness are often discovered when exercises are being done for the first time, and beginners of a certain age must not be alarmed if their spine seems to emit cracks and loud grinding sounds during the unaccustomed movements: the sounds are much exaggerated by bone-conduction to the auditory mechanism. Headache and stiffness are both caused by uncomfortable head positions during heavy sleep, and sharp, snappy, rotation of the head, while standing at attention, and careful backward bending, repeated rhythmically many times, will quickly drive this type of annoyance away.

If one shoulder has become depressed owing to constant weight bearing it down, as may happen to a labourer engaged in hod-carrying, or from continued downward strain on one limb, some form of remedial exercise is indicated. Naturally, the aim is to educate the affected muscles to overcome the stretching which has occurred; this can be accomplished by practising the reverse procedure, i.e. forcing them to perform repeatedly the action of lifting the shoulder against resistance. The force may possibly be supplied by will-power over the antagonizing (opposite) group of muscles, or by holding a weight in the hand while the shoulder is repeatedly 'hunched,' the muscles of the other shoulder being relaxed by supporting the arm on some convenient object. Great concentration is required on the part of the exerciser, the mind and observation never being allowed to wander from the job in hand. Not until the affected part can be relaxed without falling into the wrong position can the tone of the muscles be judged to have been restored.

EXERCISES AND HERNIA (RUPTURE).

The presence of a hernia, or weakness of the abdominal muscles pointing to the imminence of a rupture, does not preclude the performance of exercises. Indeed, the amount of physical strain that sufferers from really large ruptures can undergo is amazing. But as a rule the ruptured must keep their weak place well guarded by a good

truss. The development of a rupture may be checked, and occasionally a slight one cured, by exercises of the type of Nos. 3 and 8, described on pages 216 and 218. It is recommended that the hand of the same side should be employed to keep the extruded bowel in place during the exercises. As the muscles of the abdominal wall are arranged in three layers, their fibres running roughly in three directions, the strengthening of them all is a difficult problem. The central vertical muscle is exercised by body-bending and stretching, by raising the body from the supine to the sitting position, by raising the legs from the ground while the body remains supine, and by protrusion and indrawing of the abdominal wall. This muscle is absolutely separate from the three 'layer' muscles. Side-bending of the body with the thigh and buttock of the same side relaxed, and the abdominal wall retracted, is perhaps the best way of strengthening the other muscles. The safest exercise, and the one which best indicates the amount of control possessed by the individual over his belly, is repeated forcible retraction with inhalation, and relaxation with exhalation: forcible protrusion is not advisable in case the rupture suddenly breaks through. Cycling is the best and safest exercise for those suffering from rupture.

Injuries to Joints and Value of Massage

It will be assumed throughout this portion of the section that the possibility of fracture of bones has been excluded in every case described.

Joints differ widely in their range of movement, some having only a simple 'hinge' action, others a certain amount of definite movement in every direction, and some with hardly any capacity for movement at all. Joints also differ as to their stability, some being supported by tremendously strong ligaments and muscles, whilst others depend more on the firmness of their bony architecture. They may be 'strained,' 'sprained,' or dislocated. As we cannot deal here with any injuries but the first two, let us assume that all dislocations have been converted by manipulation into sprains. In this condition massage and passive movements together with rest must precede active movements. The purpose of massage is to promote the circulation of blood and lymph through the injured part; and of the movements, to prevent the formation of adhesions between the mobile elements of the joint-supports. If the tentative performance of mild active movements produces no severe pain, it is usually found in practice that the sooner the joint is mobilized, the better the result will be. On the other hand, great harm is done by too heroic perseverance if: (1) the internal part of the joint is injured; or (2) there is any tearing of ligament or avulsion of tendon. There is a difference between the character of the swelling

round a joint, and swelling of the joint itself; the latter is caused by fluid, and in the case of injury of the knee-joint can be detected easily by the manner in which it fills up the hollows on each side of the knee-cap when the knee is flexed to right angles, and its fluctuating character when gently palpated by the finger-tips. We can also distinguish between the sensations of differing causes of interference with movement. The usual tumid swelling caused by strain of the joint-supports gently impedes movement, but displacement of cartilage 'locks' the joint at a definite point beyond which no further movement is possible. Doctors who have experience in the treatment of those who are recovering from injuries know well that the keen 'physical culture' enthusiast will give points to the flabby type of man in speed of regaining the use of his limbs—indeed, this applies to every convalescence.

After the shoulder has been badly strained—for instance, after dislocation—it can be put into use almost at once. But any movement involving raising of the arm above shoulder level must be very carefully made. This joint is almost completely dependent upon muscles for its support: its socket is extremely shallow, and its ligaments have to be adaptable to the very free movement demanded by its function. Recurring dislocation of the shoulder joint is so easily acquired that surprising complications may arise. It may occur during sleep as one turns in bed. The writer knows of at least one young bride upon her honeymoon being greatly startled by a sudden yell from her husband, who had 'put out' his shoulder while turning in bed; and the same individual had his shoulder dislocated through the steering-wheel of his car spinning as it struck a boulder, the joint going in again as the front wheels rectified. Free exercises, in a case of this kind, must be prohibited, but the great back muscles, the 'chest' muscles, and the deltoid muscle should be developed as much as possible by exercises such as No. 2 and No. 4, illustrated on pages 217 and 218, the latter exercise only to be carried out after much of the strength has returned to the joint. The worst strain of the shoulder joint occurs when the arm is forced back whilst it is raised straight above the head with the palm of the hand facing forwards and the elbow stiff. The muscles are torn and the front part of the great 'capsular' ligament wrenched from its attachment.

What can be done by massage in cases of this kind? Although the muscles of the shoulder appear so massive that 'stroking' (effleurage) will not help matters, one result of injury—aching pain—is much helped by firm rhythmic massage of this kind over every part of the region. Relaxation of the abused muscles is greatly helped by stroking; and deep friction and kneading performed by circular and to-and-fro movements of the fingers as they gently seek out the tender places also relieves pain by reducing swelling. Owing to partial disuse of the arm,

its muscles and those of the hand must be kept in condition by means of some exercise which does not involve movement of the shoulder. The following is a valuable auxiliary exercise. Clench the fist with the wrist bent backward to its full extent, then forcibly flex the wrist, at the same time supinating the forearm, bend back the wrist again, and return to the original position; by repetition a combined rotatory-flexing-extending motion develops, bringing in useful contraction of all the muscles of the forearm and most of those of the upper arm in turn. If the arm is kept still the exercise is a 'stiff' one, but if slow flexion and extension at the elbow are combined with it, the whole arm enters into a rhythmic series of evolutions.

Bruising of the ribs is one of the commonplaces of manly sports. Any severe bruising, including fracture of a rib, is best treated by wide application of adhesive plaster strapping applied to limit the expansion of the chest; massage, and redevelopment exercises, must be postponed until this is removed. The extra-painful nature of bruises here is due to the crushing of the complicated muscular system against the ever-moving bones of the chest. Complete restoration of function is hastened by exercises such as Nos. 1, 2, 5, and 8 (see section on The Townsman, pages 216 to 220). Learn here the secret of being able to add one-half to one inch to your chest measurement—a valuable trick to know if your chest is just below the standard of one of the services or the police force. Having inspired to the full extent of your powers, quietly but forcibly twist both arms, as they hang at your side, inwards with the hands slightly clenched; as this is done the pectoral muscles are put into strong contraction, when they will cause the measuring tape to 'give' to the extent of almost an inch.

General Health

Constipation and downward displacement of abdominal organs is well treated by the exercises detailed for developing the muscles of the abdominal wall; and, generally speaking, the whole practice of morning exercises encourages natural functions. In addition, the action of the intestines may be stimulated by rolling a large ball of wool firmly round over the abdomen, while the body is reclining. The more active exercises, such as 'stationary running,' are indicated for younger people who are inclined to be sluggish.

By the common-sense application to other similar cases of the knowledge acquired from the examples here chosen for full description, it is hoped that the reader will be able to dispense with redundant information. It has been possible to give comparatively full accounts of these examples alone, but the full accounts should prove of more value than an incomplete description of a confusing multitude of minor disorders, entailing much repetition.

XV—EXERCISE IN RELATION TO OBESITY

THE fashion of the day is perhaps worthy of praise: but fashion becomes ridiculous when its followers push slavish imitation to excess. Banting and Fletcher are two names which come to mind as 'prophets'—alas, Banting became a verb, and Fletcherism a fad.

It is easier to remain slim than to get slim. Women, in particular, although apparently united in their horror of stoutness, are slow to observe the first blurring of their maidenly outline. Few quasi-medical subjects have been so worked to death or so diversely treated by journalistic experts in 'The Ladies' Page' of newspapers. We can hardly blame the anxious public if confusion of thought exists, so many are the divergencies found in the advice given by one 'expert' after another. That the matter is really extremely simple to understand, and can be explained in ordinary words to the most 'unscientific' intelligence, was exemplified by a lecture by Professor Munro at a congress of medical food-experts a few months ago. Perhaps it will prove an advantage to those who are puzzled over certain aspects of the question, to have the opportunity of studying the normal process of change in an imaginary and perfectly healthy life, before considering the ways and means of conserving the figure. Let us imagine an Ideal Girl.

The heredity of our ideal girl was good. There were no cases known of over-stoutness, either in her dead or living progenitors. Her mother had passed through the Victorian era with honours; while admitting the fashionable plumpness of her day, she had never found need to go in for 'banting' and, even as a young girl, had not required padding, necessary to her skinny friends, to fill and support the fashions of that time. Her father, even at over sixty years of age, could easily take part in all the moderately active sports, and had no need to restrain his still healthy appetite. The ideal girl was slim, but not thin. Her figure lines were smooth. She had plenty of fat, though she would have been horrified if she had been told so; she also had enough muscle, or those beautiful lines could not have existed, but she had small bones—a dainty skeleton. This lucky young woman also possessed perfect teeth, and had a healthy appetite for good plain food, and knew not the meaning of indigestion or constipation. In her young days girls had never so much as heard of 'cocktails,' which was a 'good thing.' But games were becoming popular in girls' schools, and she played hockey, tennis, and golf, while swimming and dancing were her pet sports. She also rode, having lessons in riding at school, but did not care for hunting.

Naturally enough her attractions were not wasted, and she married: then, according to Nature's laws, she had a child. While recovering from her confinement her doctor recommended her to perform certain easy exercises in bed. He explained to her that many young mothers lost control of their abdominal muscles by resting them too long after the tremendous stretching which they had undergone; and that this led to the spreading round and through them of fat, and the displacement downward of internal organs which missed the support needed to keep them in place. These exercises consisted of raising the body erect while the nurse held her feet down, and raising the feet (keeping the knees straight), while the nurse helped to keep her head from leaving the pillow. The exercise was begun gently, but in a few days the young mother could dispense with help, and perform each movement six times running. She also practised deep breathing several times daily, and hand and foot flexing and extending, to keep the muscles of her legs and arms from becoming flabby. She did not feel nearly so weak, and her back did not ache so much, as her mother had expected, and she was able to nurse her baby quite easily. She found that her appetite for fatty and milk-forming foods was increasing; meat, which had been removed from her diet during the last few weeks of pregnancy by her doctor's orders, still did not appeal to her.

Her figure had changed. The bust had become much larger, mainly because of lactation, but also owing to the deposit of a certain amount of new fat below the breasts. Her waistline was also appreciably larger, and the hips broad in comparison with their old measurement. It had become impossible for her to take the same amount of exercise, household duties and the nursery had taken its place. After the baby was weaned its mother was able to resume many of her former open-air activities. She had all along kept up the exercises which her doctor had taught her, and in addition had practised some dancing exercises which she remembered learning at school. The youthful appearance of her figure returned, thanks to her care of herself and the sensible attitude of her husband towards her playing of games. After a while this cycle of events was repeated, but even after having several children our perfect specimen hardly realized that her youthful figure had almost become a thing of the past, and that early middle age was setting in. Soon after she reached forty years of age she became alarmed at her increasing measurements; as a matter of fact she was made alarmed by the fussing of a 'busybody,' whereas she really felt perfectly well. Her doctor having informed her that she could not expect to be other than she was, this simple woman went home, and ceased to worry about the unattainable. Beyond following some simple rules of diet in relation to formation of superfluous fat, and taking a good walk every day, our comfortably proportioned friend worries not at all about her size. None

of her family, even in old age, have ever been too 'stout.' This is a picture of a truly normal woman, who began with advantages of good heredity, perfect health, and common sense.

There are infinite variations from the perfection of the life sketched in the preceding paragraphs. There are big-boned girls, who remain apparently slim to the end of their teens, whilst 'thinness'—lack of normal fat—preserves the illusion. 'Poor thing,' murmurs one, as her mother sits down beside her. The fate of her daughter, whose lines are those of her mother in miniature, is obvious to the trained eye. This example of womanhood will inevitably have a struggle to escape the trammels of fat, particularly if she marries and children arrive. Can she do nothing to avoid this fate? We shall see.

There are, of course, many women—and men—who descend from families of a fixed thin type. The truly thin stock is rather uncommon, but this type of heredity is remarkably exact in its reproduction—generation after generation—of tall, thin people, who seem incapable of adding an ounce of fat to their weight. It is not to be thought that this type of man or woman is necessarily delicate. Indeed, the thin individual appears to possess much more vitality than the over-stout person. We find many more cases of liver and gall-bladder disease among stout women than we do among normal women. While stout men are usually cheerful and buoyant in nature, the thinner type, though handicapped by lack of weight in some ways, shows much more hardiness and resistance to disease. As in all problems of Nature, the average is the best: exact compensation is, after all, the abstract condition of all perfect compositions.

There have been recent signs of rebellion against the cult of the slim figure. Let us hope that this revolt succeeds, without allowing the other extreme to gain. There have been too many tragedies caused by determined attempts by women to gain impossible reductions of weight. Angularity, coupled with bad health, is a common result of over-slimming, undertaken quite unnecessarily by those who must be 'in the fashion.' It was, of course, quite as absurd for Victorian women to follow the cult of the full figure to the extent of padding with uncomfortable contraptions in order to be able to support the dress-creations of the day. Plumpness was the ideal then—to-day it is pathological leanness.

While there is no slimming cult admitted by men, no man should be content to become uncomfortably bulky. By reason of family tendency, or environmental circumstances, many men have to take constant precautions against increasing fat deposit.

Exercise Preventive of Stoutness

It is a tragic circumstance when an injury forces a heavily-built man to give up strenuous games and exercise while he is yet young, unless he is able and willing to perform regular exercise of a different kind to keep down his weight. The man who over-indulges himself in eating and drinking after he has stopped entering into the games of youth, without putting substitute exercise in their place, has himself to thank for the result. And how can any woman of thirty years of age, who has not dieted, and who does not like physical exercise, possibly expect to emulate her favourite film actress in slimness? The 'star' can probably wrap both legs round her neck, and does hours of more or less acrobatic dancing every day of her life.

Women, and to a less degree men, should not do precisely the same kind of daily exercises as have been advised as a general routine for most people, if the one result of loss of weight and prevention of fat is aimed at. Exercise, as opposed to exercises, is more suitable for the fat who seek after slimness, and ingenuity is required to 'gild the pill.' Human nature is such that it abhors monotony, and time in unlimited quantities is not always at the disposal of ordinary persons. Therefore it is necessary to concentrate interesting and mildly acrobatic movements in a short system which can be conveniently performed in part or as a whole, with certain repetitions which can be varied in number according to performance, and according to the characteristics of different performers. The chosen movements should be those which demand the use of groups of muscles, and easy, automatic co-ordination—resembling natural rather than out-of-the-way action. We are not striving to make masses of muscles, but to unmake masses of fat. The only muscles which we cannot over-develop are those of the abdomen, and they are perhaps the most difficult to control. The strengthening of muscle-groups of this kind can best be done by exercises well-devised for the purpose, rather than by attempts at concentration on the part of the exerciser. The system must consist of free, rhythmic movements, easily repeated and blended with each other, and should be performed until perspiration breaks out, and the respirations are quickened. Skipping, hopping, active dancing steps for the lower limbs, and arm and trunk auxiliary movements of a snappy character, avoiding the bearing of weight or strain longer than momentarily, give an idea of what is wanted. It is found that every one, after buckling to the matter seriously, forms a personal standard: a private view of some of our tubby friends' gyrations would be highly entertaining, no doubt.

The devising of these exercises is much helped by a little study of human nature. It is difficult to persuade some people to perform, let

us say, twenty 'hops' if the 'hops' are all the same. But vary the steps, and, hey presto, we have a dancing exercise. As follows: Stand with hands on hips, fingers to the front, at 'attention' (as regards the general position); jump slightly, and at the same time separate the feet about eighteen inches; then smartly shoot the arms straight above the head, parallel to each other, and palms to the front; swing forward and down, letting the body bend easily at the waist, until the fingers have brushed the floor, and the arms have swung through the arch of the legs; regain the upright position with the return swing, never having checked it; finally replace the hands on hips, and jump the feet together again: as this exercise is practised it will be possible to swing more and more freely while keeping the knees straight—but do not force the position at any point in the swing, which should be fast and rhythmic. A series of variations can be introduced here, before the swinging of the body. This consists of rapid 'scissor' movements of the legs and feet based on the simple 'jump' separation of the feet which was necessary before the arms could be swung between the legs, and can be compared with 'sword-dance' steps performed without the pointing of the toes. In the first position the feet are to be placed eighteen inches apart; they are then placed together by means of another rapid movement; next, one foot is advanced and the other put back equal distances by means of the same strength of spring, and replaced together; then the opposite is performed. Rapid repetition of these simple steps cannot fail to assist in dispelling some of the monotony of duty, and diagonal additions supply a ready-made substitute for the fashionable 'tap-dance.' Plain hopping on each foot alternately, with the knee in various degrees of flexion, and with increasing energy put into the exercise, is one of the best exercises for general muscular development of the legs and thighs, but can be carried to excess if it is not varied and softened by swinging accompaniment of the limb which is off the ground. An easy change is made by doing a double hop alternately on each foot while the other leg is swung loosely outward and inward, or forward and backward. Owing to the easy, 'automatic' rhythm of this exercise, it can be 'kept up' without appreciable exertion for long periods,. when the more intricate exercises do not suit the mood of the moment. Arm movements which appeal can be performed in conjunction with this leg-swinging, and if the performer cares to shift her ground while the arms are swayed and the body is curved this way and that, a most graceful dance can be evolved, which may make a pleasure to the eye out of a duty to the body. Following the rule of developing agility and grace of movement rather than pure muscularity, never repeat any exercise until one particular muscle becomes stiff and tired, but remember to aim at a general elevation of body-heat, and a quickened rate of breathing.

'GROUND EXERCISE.'

The cultivation of the performance of various ways of 'getting up and down' is interesting, and perhaps those who have accumulated rather more adipose tissue than the still graceful performers of the first class of exercise will find something of this kind more suitable to their needs: Shoot the arms above the head from the position of attention, then do the 'double knee bend,' bringing the hands smartly to the hips; place one hand on the ground, leaning slightly to this side, and take most of the weight on the supporting arm; then shoot both legs forward, as straight as possible, and try to land lightly in a sitting position, simultaneously bringing the other hand down to the ground to share the weight, having 'pushed off' with the arm which was first used for support; regain the position of 'double knee bend,' and repeat the 'sitting down' movement, using the arms in the reverse order; regain the standing position by placing both hands on the ground just in front of the point of balance, and smartly jumping up, sharing the effort between the straightening legs and the arms; the feet have been brought back to the correct position in the composite first movement, the temporary position before returning to attention being something like that of a sprinter waiting to 'take off.' The upright position can be reached by simply pressing up without the aid of the arms, but the choice of the first method is made to avoid the stress on the extensor muscles of the lower limbs, which might prove too much for really heavy people until they have reduced to some extent.

Another attractive set of movements which keep the back and loins, the hamstring muscles, and, indirectly, the abdominal muscles, working well in unison, can be initiated from the crouched position indicated above: putting considerable effort into the commencement, the weight is transferred to the arms by swaying slightly forward; the whole body is then straightened while the legs are shot backwards until the toes rest on the ground, heels together; the position of the body has to be strictly studied; it must appear as if it were in the position of attention, except for the plane, and the position of the arms which are acting as supports; the crouching position is resumed by bringing the feet smartly up to the hands by a general muscular effort which brings in the abdominal muscles particularly. A detailed description of the positions adopted in this exercise will help to impress it upon the reader. I. 'Shun, hands on hips. II. Double knee bend, hands on hips. III. Double knee bend, hands flat on ground, fingers together pointing forward, arms width of shoulders. IV. Body balanced on arms as in previous position, and on the toes, legs straight, heels together, body straight and head in line, eyes looking down. V. Double arm bend, chest just touching ground, body unmoved. V is followed by resuming position

of IV by pressing up with the arms, III position resumed by doubling up the body and bringing the feet up to the hands, then the upright position follows. Any single movement can be repeated at the pleasure of the exerciser.

EXERCISES DEMANDING AGILITY.

An old 'gym' punishment forms an excellent exercise for the more agile: Double knee bend; hands on hips; hop repeatedly. This can be done without changing stance, or ground may be gained with each hop. It is ludicrous to feel one's balance being lost as the legs tire. While in the knee-bend position ordinary arm exercises can be done, another excellent method of practising balance. This class of exercise is, *par excellence*, for girls' practice who wish to anticipate any hint of losing their slimness. You must have seen 'Russian' dancing. It is not nearly so difficult, except in the way of keeping up for a long time, as it looks. Each leg is kicked out in turn from the knee-bend position, and the ground tapped with the heel: as the foot is drawn in it may be altered a shade from the previous position, and in this way quite rapid progression can be made. An even more acrobatic variation is to shoot both feet out to the limit of the abduction of the hip-joints, springing just sufficiently to avoid scraping the floor, which will cause a tumble. It can well be imagined, after this exercise has been attempted, that fat would have a hard struggle to deposit itself upon a Russian dancer.

'Stationary' running, although it can never take the place of proper running exercise, can be made quite an interesting daily task if the eye be kept upon the clock, and the mind upon the muscle-groups in use. The exercise detailed for flat-foot will keep the legs in shape; here, once more, care is necessary to avoid over-development of the calf-muscles. If varicose veins have already put in an appearance, over-exercising will only make matters worse. Excessive toe-dancing can produce the ugliest legs imaginable; it is purgatory to a lover of grace and form to be forced to sit close to the stage while one of the muscular type of ballet-dancer thuds, stiff-legged, about the boards. The lissom grace of the cultured dancer as she pirouettes for a moment during her interpretation of a piece of music can never depend upon the possession of brawny masses of flesh, but upon perfect co-ordination of slim, pliable, muscles.

EXERCISES FOR ORDINARY OBESITY.

When fat has become a burden to either man or woman there is a great probability that other faults are present, particularly if the condition has appeared suddenly or increased rapidly. The cause of the obesity, and the state of the heart and other organs must be investigated

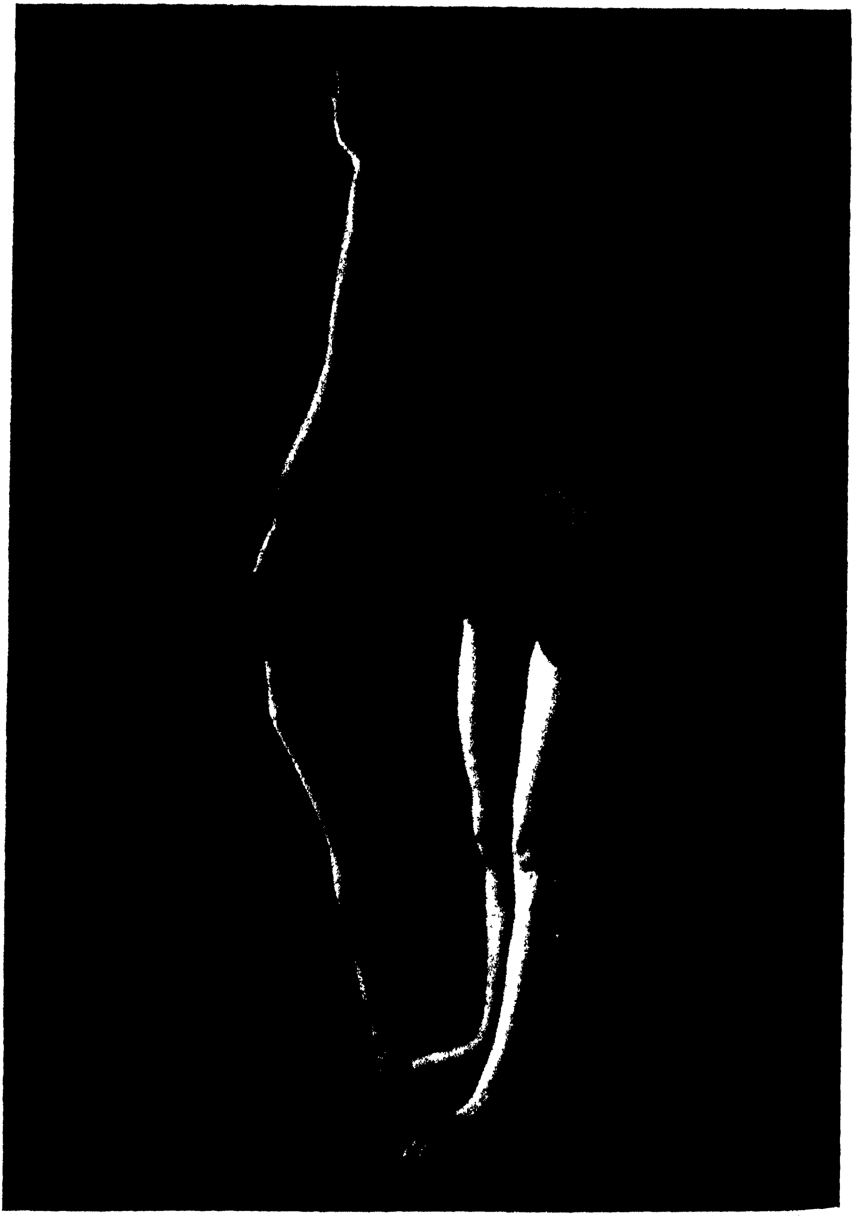
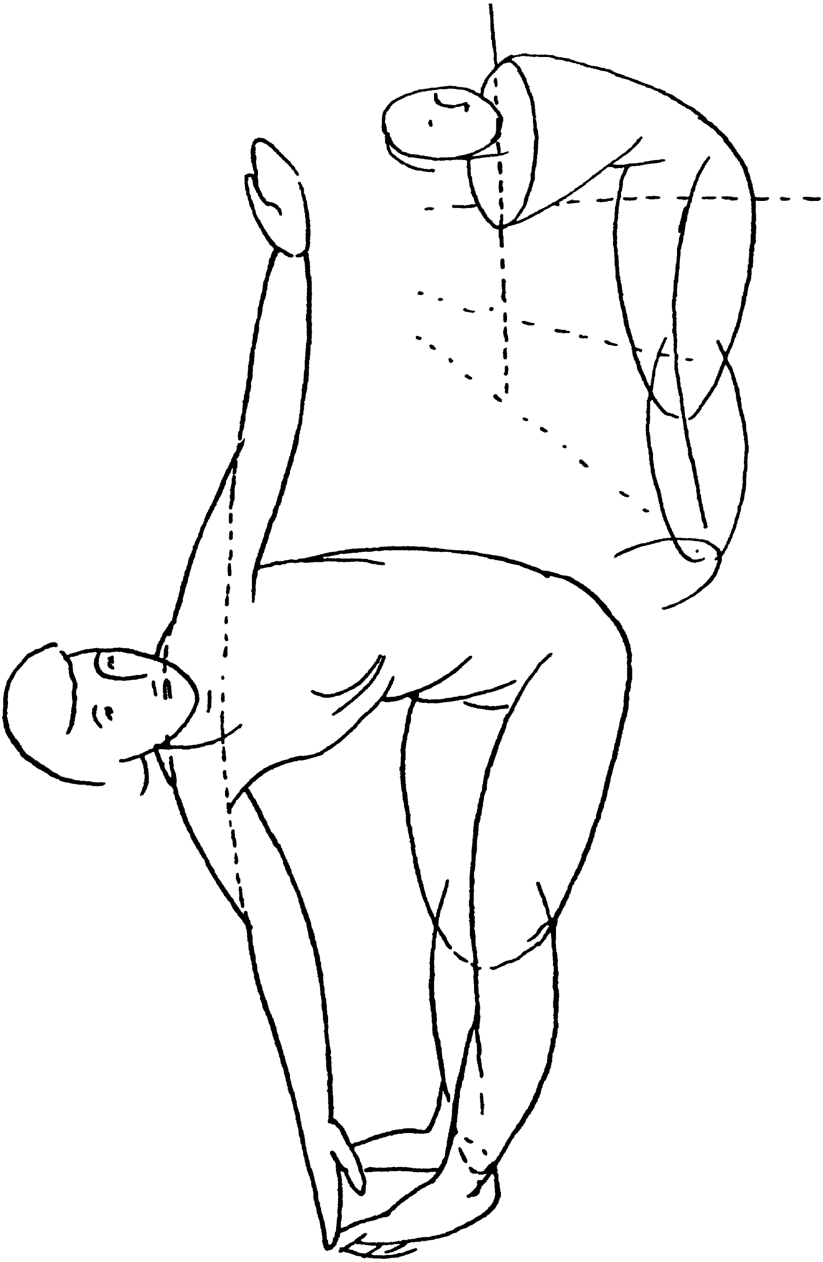


Photo by Herbert Williams

DOUBLE BEND AT THE WAIST—FORWARDS AND SIDEWAYS

Shoulder-line vertical, hip-line horizontal, and both at right angles to one another



DOUBLE BEND AT THE WAIST
Forwards and Sideways

before exercise is apportioned. The very fact that any one has reached this unenviable state indicates that the battle against fat has been lost.

It is found sometimes that a habit of laziness has been formed owing to some injury having curtailed normal activity for a time and no effort having been made to get out of the rut. Others have given in without a struggle. Others have not understood correct dieting. Others (and are they so rare?) have preferred self-indulgence to extra trouble, and have the good or ill fortune to be able to live without needing to move their bodies much from place to place. We can thank fat for a great deal of philosophy, and philosophy for a great deal of fat.

Walking is the best exercise for the obese. By means of perseverance and urging on, from a slow and short walk to begin with, our fat friends often puff and pant back to health, provided that their diet is strict. Perspiration comes easily to stout people, so that motion need not be swift. When outdoor exercise is impossible, everything must be done to prevent the daily task from being neglected. Massage can be used as an adjunct to help flabby muscles, but is useless for fat reduction. The idea that any skilled masseur, or any instrument or application, can melt away a lump of fat as if by magic, is false. The fact is, that the use of appliances automatically leads to the user expending some energy. The vigorous use of the bath-towel serves as well as any other method. The main point to understand in this connection is plain: if obesity has to be dealt with the performance of ordinary physical exercises is impossible. 'No one can be considered obese who can still put his own boots on!' is how one expert expressed it.

The employment of an assistant and the use of apparatus help to solve the problem and, as massage and hot baths under skilled supervision help in their way, all difficulties are better overcome if the treatment is entrusted to a recognized gymnastic instructor who has experience in varied forms of physical training. Ground exercises of raising and lowering the body while the feet are held by a bar or an assistant, followed by leg-raising, as detailed before, give the abdominal muscles good and easy exercise. Stationary rowing on a sliding seat is excellent exercise, and is becoming popular. The use of the medicine ball—a large soft ball covered with thin leather, which is tossed from one to another of any number of persons—gives a play-like interlude, while affording excellent exercise for the whole body as well as the arms. Instructors become adept at detecting when their charges—who, though mostly men past middle age, may be as difficult to handle as children—have been breaking rules of diet. Men who have not dreamed of 'cycling' for years, after enjoying its 'stationary' substitute, begin to think of taking to the road again. As gentle progress is made, the heart shares in the general improvement, and minor ills fade away. During treatment of this kind careful watch must be kept for small ruptures,

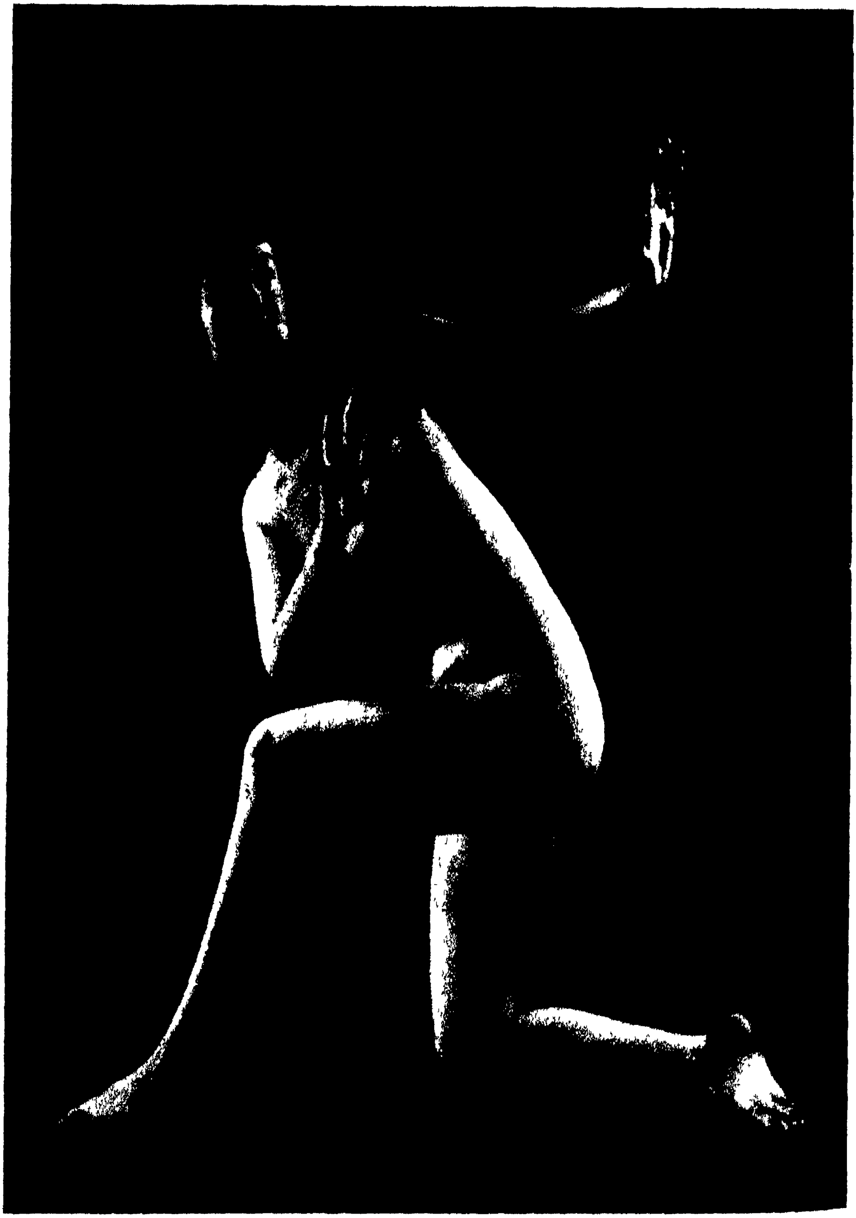


Photo by Herbert Williams

BALANCED MOVEMENT—TWO-WAY TWIST

TWO-WAY TWIST

as fat people are prone to this weakness; and weakness of the arches of the feet is also common. After the daily course has been taken, a Russian bath and cold spray, followed by the drinking of a cup of milkless tea with lemon and no sugar during fifteen minutes' rest, will remove any feeling of tiredness.

Glandular Disease and Constipation

For those whose obesity is caused by failure of control on the part of their 'ductless glands,' medical help alone is advised. After all that can be done by medical treatment has been done, and matters of dosage of drugs fixed, however, general treatment is usually no different from what has been advised for ordinary obesity. There is one fact, however, which should be known by every man and every woman. Constipation leads to poisoning of the whole system; this fact is well known and appreciated. But it is not generally appreciated that constipation has any connection whatever with obesity. If other organs are damaged by poisons why are the ductless glands considered immune? They are not immune. In nearly every case of early thyroid and pituitary disease with symptoms of typical weight disturbance there is a 'history' of intractable constipation. In addition to the advice given above another means of stimulating the intestines can be used. After performing the prescribed exercises for strengthening the abdominal wall, both fists are clenched, and the whole abdomen thoroughly pummelled, particularly up and down the centre. The 'solar plexus' area, in the centre just under the breastbone, will be detected as the weakest point, and its power of resistance can be taken as a good guide in judging the strength of the blows. A man should be able to put nearly all his force into the pummelling, without hurting himself, and a woman ought to be able to hit nearly as hard.

XVI—SOME ANIMAL PARASITES

Of all man's animal parasites, the microscopic unicellular organism responsible for the terrible and devastating disease known as malaria is perhaps his most serious enemy. This animalcule spends part of its existence in the human blood, the symptoms to which it gives rise in man being due to the disintegration of the red blood corpuscles which it brings about. The malaria germ, or plasmodium, is introduced into the human body by the bite of a particular kind of mosquito, which has itself been infected. The parasite goes through two stages, only one of which is passed in man, the other in the mosquito. The mosquito becomes infected if it sucks the blood of a malaria subject.

The disease was once common in this country, and it is still prevalent in many parts of the world. The mosquito lays its eggs in water, and these eggs hatch into small wriggling larvae that move about in the water rather like tadpoles. Wherever there are stagnant pools, watery ditches, or open rainwater tanks, thousands of these larvae will generally be found, in summer, swimming near the surface. In some countries previously subject to decimating waves of malaria, the disease has been practically stamped out by draining the marshes, and otherwise reducing to a minimum the mosquito's breeding-places. Coincidently, isolation of malaria patients has been carried out, so that the mosquitoes that still exist may not become infected by sucking human blood containing the parasite. The one drug that has been found effective in the treatment of malaria is quinine, prepared from the bark of the cinchona tree. The potency of this bark was discovered by the native Indians of America, and the knowledge was brought to Europe by Catholic missionaries. People travelling in tropical countries where malaria and the specific mosquito that conveys it are common can reduce their risk to a minimum by taking daily doses of quinine, and by sleeping within mosquito-proof netting.

Another kind of mosquito carries the organism responsible for the tropical disease, yellow fever. This mosquito also spends its larval existence in water, but, as it usually does not travel far from the habitations of man, laying its eggs principally in tanks and cisterns in proximity to human settlements, it can be eradicated by simpler and less extensive measures than are necessary for the eradication of the malaria mosquito.

Bubonic plague, the 'black death' of the Middle Ages, is still one of the commonest causes of human death. It also is conveyed by the bite

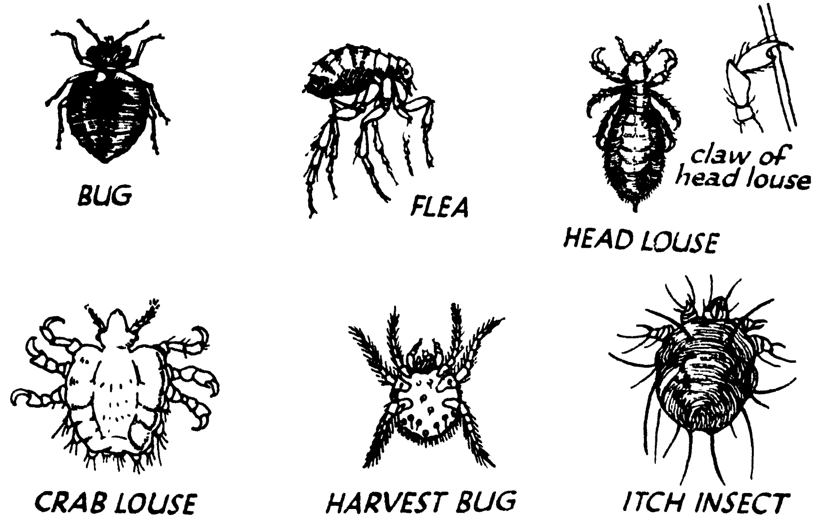
of insects, the carrier being the rat-flea. The black rat is the species on which this flea is mainly parasitic, and the disease is primarily one of rats. This parasite spends part of its existence in the blood of rat or man, part of it in the rat-flea. When the flea sucks the blood of a rat or a man affected with the diseases it in turn becomes infected, and capable of conveying the infection to individuals subsequently bitten or pierced by it. Bubonic plague has, except for a few imported cases, been unknown in this country for a very long time—approximately since the brown rat displaced the black rat as a resident here. Elaborate precautions are taken at all our ports to prevent the landing of black rats that may have travelled across sea as stowaways.

The bed-bug is a potential carrier of typhus fever; but, typhus having practically been exorcized, the bite of this unpleasant insect is, in Great Britain, comparatively harmless. It is still fairly common in crowded slum districts, and is not infrequently to be found in better-favoured homes. Once it secures a lodgment it is extremely difficult to eradicate. It visits the human body but to pierce the skin and suck the blood, and this it does in the hours of darkness. By day it conceals itself in crevices of the bedstead, or in cracks in the wall or fittings of the room. No crack seems too narrow for the bug to enter. It thus evades such measures as fumigation and spraying; but, if all the contents of a room are baked or otherwise subjected to great heat, and the plastering of the wall made impervious, the floor being saturated with strong poisonous solution, and the room sealed and fumigated with burning sulphur, the pest can usually be got rid of, though the process may have to be repeated several times.

Fleas are much easier to get rid of than are bugs. The generous employment of soap and water, supplemented by sulphur fumigation, makes their eradication a relatively simple matter. Three kinds of louse are still far from rare in Great Britain. There is the head-louse, which makes the scalp its home and pasture-ground; the crab-louse, which chiefly occupies the hairy part of the pubes; and the body-louse, which lives in the clothing, and visits the body only for nourishment. Head-lice and crab-lice lay their eggs on the hairs of their respective hunting grounds. The body-louse deposits its eggs not only on the small hairs of the skin, but also on the clothes. The nits are firmly stuck to the hairs or clothing by a sort of cement, and are usually not very easy to detach. Nits take about a week to hatch, and the young reach maturity in about a fortnight after birth.

The presence of lice is generally made known by the intense irritation of the skin which they provoke. As a result of the consequent scratching, surface infection is common, and neighbouring lymphatic glands may become swollen and tender. Fortunately, pediculosis, as a louse-infected condition is called, is amenable to treatment if it be carried out

persistently and with assiduity. In the case of the head-louse and the pubic louse, the first thing is to cut as short as possible the hairs of the affected region. Twice daily until all trace of these nauseous insects has disappeared, the shortened hair should be thoroughly combed with a fine-toothed comb. After the combing, the parts should be vigorously scrubbed with warm water and Derbac soap, or, if this is difficult to obtain, coal-tar soap. The skin, having been dried by thorough rubbing with a towel, a little perchloride of mercury lotion, of a strength one in two thousand, should be well rubbed in. Lastly, ammoniated mercury



EXTERNAL PARASITES

ointment may usefully be applied. The whole of these procedures should be carried out systematically, twice daily, until not a louse or nit can be found. The body louse presents a somewhat more complex problem. To begin with, all bedclothing and all linen that has been in contact with the skin should be baked in a disinfecting apparatus or be boiled in water. Twice a day, the whole surface of the body should be vigorously washed with coal-tar soap and warm water containing a generous allowance of washing soda. Before the washing, it is a good plan to rub into the skin—at any rate of those parts notably affected—an equal mixture of olive oil and common lamp paraffin, the warm water and soap being used some ten minutes later. The thing to bear in mind is that half-hearted or irregularly applied treatment is useless; whereas regular and persistent treatment is invariably successful—though a measure of patience may be called for.

Another parasite which not infrequently attacks the surface of the

human body is the small eight-legged animal known as the *Acarus scabiei*, or 'itch insect'—though it is not strictly an insect. The acarus is about one-eightieth of an inch long. The female, when impregnated, burrows its way into the surface-layers of the skin, and there lays her eggs. She continues to lengthen her tunnel, depositing eggs as she travels, so long as she lives. These eggs hatch out into larvae in about ten days. The acarus secretes an intensely irritating fluid, which gives rise to the distressing itching from which symptom the parasite derives its colloquial name. It is only the impregnated female that makes the characteristic burrows or tunnels. These passages average in length about a quarter of an inch, and follow a somewhat sinuous course. As a result of the irritation set up by the creature's secretions, as well as of the almost unavoidable scratching by the unfortunate victim, numerous sores, papules, and suppurating vesicles manifest themselves on the surface of the affected regions. The hands and wrists are perhaps the parts most frequently affected, the web between the fingers being especially liable to invasion; but the surface of the trunk, including the buttocks and the genital organs, is often involved.

Scabies, which is the name given to the consequent disorder, is, as one might expect, contagious. It is readily caught by contact with persons already infected by the acarus, as well as by sleeping in beds previously occupied by individuals suffering from scabies. Owing to the inadequacy of their homes and cleansing facilities, the poor more frequently suffer from scabies than do the rich; but no class is exempt, and the trouble is found in persons of every station, of every age, and of both sexes.

If left untreated, the disease may spread, and may persist for months or even years. If actively treated, however, it can generally be got rid of in a comparatively short time; but the treatment must be really vigorous. It is best to give oneself entirely up to the cure for two or three days.

After a generous lathering with soap, and a hot bath, lasting for a quarter of an hour or more, the patient should dry himself, and then thoroughly rub into the skin of the entire body the following ointment: eighty minims of cyllin, two ounces of sulphur ointment, two ounces of paraffinum molle. Clean stockings and clean pyjamas should then be put on to prevent the ointment being rubbed off. In twenty-four hours the whole process should again be gone through, and once more repeated twenty-four hours later. All bedding and all linen previously worn should be boiled or otherwise disinfected, particular attention being paid to gloves, for it is the hands which are commonly first affected. An even more efficient ointment than the one prescribed above is what is known as Danish ointment; but this calls for much greater

skill in preparation, and is not always easy to obtain. It is often found that a single application of Danish ointment suffices.

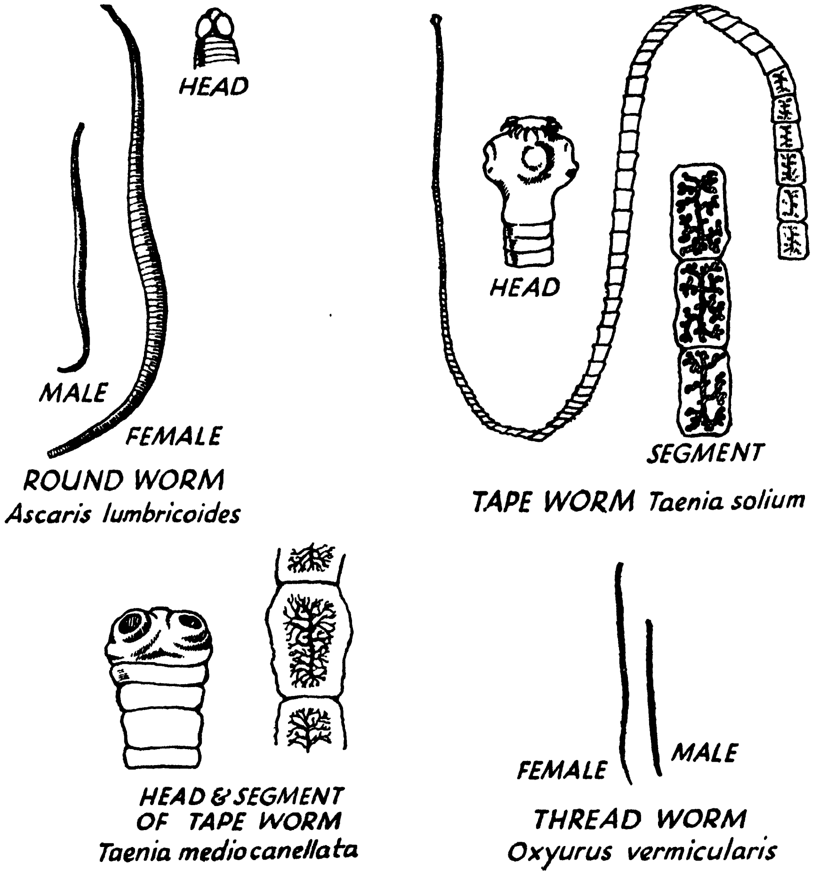
During the later months of summer, those who live in the country, especially those who inhabit chalky districts, are very liable to be troubled with the bites of a tiny acarus known as the harvest-bug. This creature is reddish or orange in colour, and is just visible, as a small speck, to the naked eye. The harvest-bug, though it sets up a violent itching of the surface which it attacks, does not burrow after the manner of the acarus responsible for scabies. The irritation to which it gives rise is, however, liable to be increased by the scratching which it is almost impossible for the victim to avoid. By way of palliative, weak solutions of ammonia may be frequently patted over the itching parts. Far more effective are preventive measures. In districts where the harvest-bug abounds, during the months when it is most active it is unwise to walk or sit in long grass, or even to stroll through a garden, with the legs uncovered. There are many substances that may, with advantage, be rubbed on to the skin of the legs, even when they are protected by coverings. Most of these preparations contain one or other of the strongly scented essential oils. Simple camphorated oil often acts as a useful preventive, as also do oil of eucalyptus and the more agreeable oil of lavender.

Internal Parasites

It is not the surface of the body only to which animal parasites attach themselves. Scarcely a tissue or an internal organ but is liable to become the home of some alien creature, which there finds nourishment ready to its needs. The number of internal parasites of man is large. Here it is proposed to give some account of a few of those more commonly met with. The organism responsible for malaria, which is introduced into man by the bite of the mosquito, has been already referred to. The following parasites are very much larger in size, and have their common habitation in the intestines. They are all popularly classed as 'worms'—though, in fact, they belong to widely differing groups of the animal kingdom.

Of the intestinal worms commonly found in this country, the tapeworm is perhaps the one most destructive of health, and at the same time most difficult to get rid of. The tapeworms spend only their adult or fully developed stage of life in the human intestine. There they grow and develop, laying eggs which, passing with the faeces, are liable to be devoured with grass or other herbage by animals, within the flesh of which they are hatched and the resulting larvae live. The two common kinds of tapeworm found in Britain are *Taenia solium*,

the larva of which inhabits the intermuscular tissue of the pig; and *Taenia saginata*, or *Taenia mediocanellata*, the larva of which is parasitic in the muscles of cattle. It is by eating what is called 'measly' pork or 'measly' beef, not completely sterilized in the process of cooking, that man becomes infected by tapeworm.



INTERNAL PARASITES

Of the two species named *Taenia*, *saginata* is the longer, sometimes reaching a length of twenty-four feet. *Taenia solium* rarely exceeds half this length. Each tapeworm consists of a small head, an even smaller neck, and a connected chain of body segments, each increasing in width according to its distance from the head. Nearly every one of these segments is equipped with male and female sex organs, and consequently is capable of reproduction. Tapeworms attach them-

selves to the wall of the intestine by means of muscular suckers situated at the head end. *Taenia solium* has also a rostellum with two circles of hooks.

As might be expected, tapeworms set up a good deal of inflammation and irritation in the mucous membrane of the bowel, though acute pain is rarely experienced. The appetite often becomes ravenous, and diarrhoea, vomiting, and a feeling of internal discomfort are not infrequent symptoms. The only certain sign of infestation by tapeworm, however, consists in the presence of segments of the worm in the faeces, or escaping from the rectum. These segments, or groups of segments, have somewhat the appearance of short pieces of tape.

The worm can generally be expelled, and its head detached from the intestinal wall, by the following treatment. For twenty-four hours the patient should take very little, and very light, food. At night-time a good dose of castor oil should be swallowed. The next morning no food should be eaten, but, first thing, fifteen-minim capsules of liquid extract of male fern should be swallowed with a little water. An adult should take six of these capsules; a child, one, two, or three, according to age. No food should be taken for some hours afterwards. An aperient, however, is advisable about four hours after the capsules.

Two kinds of round-worm are fairly common. One, known as *Ascaris lumbricoides*, is not unlike the ordinary earthworm. It is cylindrical in shape, pointed at both ends, and varies in length from six or seven inches to as many as eighteen or twenty. It is usually of a greyish-yellow colour, and is easily recognized. Commonly, a person becomes infected with round-worm by drinking water containing either the eggs or the young of the parasite. Any number of round-worms may exist in the intestine; and sometimes they form a coiled mass, which acts as a serious obstruction. Occasionally, these worms work their way up to the stomach, and may even enter the bile duct or the air passages.

Apart from these more serious possibilities, round-worms, especially in children, give rise to a variety of symptoms, including digestive disturbances, nettlerash, headache, convulsive twitching, irritability, and general discomfort. The most effective drug for the expulsion of these parasites is santonin. This should be given in powder or tablet form, first thing in the morning, on an empty stomach, for two or three days in succession. Three grains is a good dose for an adult, and from half a grain to a grain and a half for a child, according to age. It is well to follow the santonin, after an interval of a couple of hours, with a calomel powder, or a dose of castor oil.

The other common round-worm in this country is the so-called threadworm, *Oxyuris vermicularis*. Threadworms, as the name suggests, have the general appearance of small pieces of cotton. They

give rise to numerous symptoms, some not unlike those caused by ascaris; others specially characteristic of themselves. Among these latter is an intense irritation or itching in the neighbourhood of the anus; and also, in the case of girls and women, around the vulva.

Threadworms, like the larger round-worm, are generally taken into the body as eggs or immature individuals with drinking water, or with uncooked vegetables or salads. Quassia and common salt are the two most effective drugs. Every morning for a week, a solution of common salt in tepid water—about a teaspoonful to a teacupful of water—should be injected into the bowel, or allowed to flow into the bowel from a douche can, the hips being raised the while. The amount of the injection will vary from a teacupful to a pint according to the age of the patient. It is well, for two or three days, also to give doses of aperient medicine, as, sometimes, these little parasites find their way up the bowel well above the rectum.

XVII—DISEASES OF THE NERVOUS SYSTEM

DISEASES of the nervous system present the doctor with some of the most difficult problems of diagnosis in medicine—and of treatment. It is not possible to give the lay reader more than a glimpse into these problems, but it is hoped that this glimpse will enable him to take an intelligent interest in an important subject. One comfort he may take to himself; that is that diseases of the nervous system are not very common. The reader will not be able to understand this section unless he has first of all read that on the physiology of the nervous system.

METHOD OF EXAMINATION

Before passing on to a discussion of the various disorders that may afflict the brain, the spinal cord, and the nerves, we will look at the problem from the point of view of the doctor, and see how he approaches the patient. His method of examination is, or should be, based upon his knowledge of anatomy and physiology. Having taken careful account of his patient's story—of headaches, of pains, of weakness of legs or arms or, maybe, of paralysis; of disorders of hearing and vision, etc.—he observes how the patient walks, how he talks, how he holds himself, the expression on his face. In this way he makes a rough assessment of the general efficiency of the nervous system. If, for example, one leg drags when the patient walks, it may be an indication of oncoming paralysis in that limb. If one arm does not swing freely; if one side of the face appears flat compared with the other; if one eyelid droops; if the patient walks unsteadily or tends to lean to one side; if there is any alteration in speech—these and a hundred other data of observation put the experienced physician on the track of the patient's malady. Disturbances of movement, unless due to disease of bone, muscle, or joint, are evidence of an injury in some part of the nervous system.

After a general survey of his patient, the doctor proceeds to a more detailed examination. Usually he begins by testing the functional efficiency of the nerves issuing from the brain—the cranial nerves. As we saw in the section on physiology these nerves supply the muscles of the face, of the jaws, of the tongue, of swallowing (muscle of upper part of gullet), of talking (the vocal cords), and of certain muscles in the neck. So long as the muscles work all right the nerves must be intact, and the doctor asks his patient to clench the teeth,

to open and shut the eyes, to move the tongue, to move the eyes, etc., to make certain that these movements can be carried out. The cranial nerves supply the skin of the face with sensory nerves; and are associated with the special organs of sensation—subserving taste, smell, sight, and hearing. The first nerve of the brain is the nerve of smell; the second, of sight; the eighth, of hearing.

By finding out whether the sensations of touch, pain, and temperature are intact over the skin of the face, and by testing sight and hearing (smell and taste are less important), the doctor completes his examination of the cranial nerves. If he finds, say, that when the patient shows his teeth one side of the face does not move, then he knows that there must be some trouble in the course of the nerve that supplies the muscles of the face on that side, the seventh cranial nerve.

In the case of the second cranial nerve—the optic nerve which conveys 'light messages' to the brain—the physician has the advantage of being able to observe it directly. As this nerve enters the back of the eyeball to spread out into the retina lining it, its diverging fibres form a round white disk. By a special arrangement of mirrors and a light, forming an instrument called the ophthalmoscope, the doctor can look at this disk through the pupil of the eye. If there is any pressure—as, for example, by a tumour in the brain—on this nerve the disk will appear swollen. The retina also can be seen through the ophthalmoscope, with the arteries and veins spreading over it, so by means of this valuable instrument the doctor can also get a direct view of certain blood-vessels. If a patient suffers from hardening of the arteries, their thickening will be shown in the arteries of the retina.

The examination of the rest of the body is carried out with a view to detecting any abnormality in the motor and sensory nerves. The integrity of the motor nerves is assessed by testing the power of contraction of individual muscles and groups of muscles of the limbs and of the trunk. The state of the muscles themselves—whether they are flaccid and toneless, or spastic and rigid—will tell the physician what part of the motor nervous system is at fault. Investigation of the sensory nerves is a more difficult matter. As we saw in the physiology section, sensation is a complicated matter. The physician must examine the patient's response to a light touch, to pain (by pin-pricks), and to temperature, and his ability to recognize by their feel the form and texture of objects. Then he proceeds to test the muscle 'senses'—sensations of deep pressure, of position of the limb in space, of the direction of movements at joints.

A further way of finding out whether the nerves are in working order is to test the reflexes. When the tendon below the knee-cap is tapped with a little rubber hammer, with the leg hanging loosely, the leg jerks, as a result of contraction of the muscles in front of the thigh. This

automatic reflex movement can only take place if the reflex arc of motor and sensory neurones is intact. The tendon reflexes can also be examined at the elbow, wrist, and ankle joints. Certain skin reflexes are of importance. If you scratch the sole of your foot you will notice that the big toe bends (flexes). When the nerve-fibres descending from the motor area of the cerebral cortex through the brain-stem down to the spinal cord are injured in any part of their course, the big toe goes up (extends) instead of down, when the sole of the foot is scratched. This little sign is of the very greatest importance to the physician. Other superficial reflexes are of less significance from the point of view of diagnosis.

Finally, the doctor investigates the balancing and co-ordinating functions, the ability of muscle-groups to perform alternating movements, to accomplish with accuracy and without clumsiness a desired activity, to balance the body correctly on walking and turning. If these movements are carried out faultlessly, the doctor knows that the cerebellum and the nerve tracts leaving it are not diseased.

Special Methods of Diagnosis

The brain and the spinal cord are bathed in a clear liquid, the cerebro-spinal fluid. This can be examined by drawing some of it off through a hollow needle inserted between two vertebrae in the lower part of the spinal column: this is called a lumbar puncture. In infections and tumours of the brain and the spinal cord various changes in the chemistry of this fluid and in the cells in it provide the physician with some valuable diagnostic information. It is an indispensable procedure in the diagnosis of a nervous disease. Haemorrhage in the brain can be discovered in this way, as blood will appear in the cerebro-spinal fluid. For the diagnosis of brain tumours some of this fluid can be replaced by air, which will fill up the spaces, or ventricles, in the brain substance. An X-ray photograph will then often reveal the growth. Occasionally the injection into the cerebro-spinal fluid of an oil (lipiodol) opaque to X-rays will show by X-ray examination the site of the tumour.

Inflammation of the Brain

Inflammation of the brain is called encephalitis. It may occur in association with many other conditions. Encephalitis may follow injury to the brain; it may complicate the specific fevers, especially measles and scarlet fever; infection of the brain may arise from local diseased conditions, or from general (septicaemia). The main symptoms of an acute inflammation of the brain are headache, drowsiness, irritability,

convulsions, delirium, vomiting, coma (unconsciousness), and paralyses of various sorts.

There are two forms of encephalitis about which more must be said. The first of these is called acute anterior poliomyelitis, or, more popularly, infantile paralysis; and the second, lethargic encephalitis, or sleepy sickness.

Infantile Paralysis is an acute infectious disease of the nervous system caused by a filter-passing virus (see section on germ diseases, page 400). It has been proved that this virus reaches the nervous system by travelling along the nerves in the upper part of the inside of the nose. The disease is common in children of two or three years old, and is most prevalent in August and September. The virus of poliomyelitis may attack any part of the nervous system—the cerebrum, the cerebellum, the brain-stem, the meninges, the nerves, or the spinal cord. Of these the common form is the last, and we shall consider it here for the sake of convenience. What is generally known as infantile paralysis, therefore, is usually an acute inflammation of the spinal cord. As the inflammation attacks those nerve-cells in the cord whose axons go out as motor nerves to the muscles of the limbs and of the body, paralysis of these muscles is the predominant feature of the disease. If the brain-stem is attacked, paralysis of the muscles supplied by the cranial nerves occurs.

The disease starts suddenly, with fever, which usually lasts seven days. Headache, convulsions, and pains in neck, back, and or limbs are common symptoms. There may be vomiting and diarrhoea. Within two or three days of the onset paralysis of some of the muscles becomes apparent: it may be restricted to one limb or it may be more widespread; but with recovery from the acute stage of the illness some paralysis remains, though the permanent disablement is always less in extent than that observed during the acute phase. It is this disablement that makes poliomyelitis such a serious disease. During the last few years attempts have been made to prevent the paralysis by injecting serum from the blood of patients who have recovered from the disease. Such an injection should, of course, be given at the earliest possible moment, as the paralysis appears within two or three days of the onset. The most that can be said about the results so far obtained is that they are promising.

On recovery from the acute illness the patient must be very carefully nursed in order to minimize the ill-effects of the permanent paralysis. Movements, massage, electrical treatment, special splints, and operations, all have their part to play in limiting the extent of this. In any epidemic of poliomyelitis, parents should be on the look-out for feverish attacks in their children, and should call in the doctor even if the trouble appears to be 'only just a cold.'

Lethargic Encephalitis (sleepy sickness) is a disease which seems to break out at intervals and then die down for a period. The last pandemic occurred in 1917, and reached a maximum in 1920. Since then, it has gradually declined, and acute cases are now fortunately rare. It is probably caused by infection with a filter-passing virus, which attacks the brain, especially the part in the region of the thalamus (see section on physiology). The worst feature of sleepy sickness, which must not be confused with sleeping sickness, a disease of the tropics, is its after-effects. Typically, it begins as an acute illness with fever, headache, vomiting, and a heavy lethargy, the patient often sleeping during the day and remaining awake at night. Often one of the eye muscles is paralysed. But the disease may manifest itself in many forms.

It is difficult for the physician ever to say that real recovery has taken place, for paralysis may occur five or six years after the acute attack has passed. In the paralysis (known as Parkinsonism) that follows lethargic encephalitis, the patient's muscles are rigid, so that he cannot move them easily, and his hands tremble; his face is expressionless—mask-like—and, often, he dribbles saliva. With his arms slightly bent and motionless and his body bent forwards, he looks, as he walks, like a moving plaster-cast. His intellect is unimpaired, but muscular expression of thought and emotion is impossible. The other main group of changes that may follow an attack of lethargic encephalitis are 'behaviour disorders.' Mental and moral degenerative change may take place, and many children who find their way into the juvenile courts on account of stealing, violence, or perverse behaviour are found to have suffered from this disease. It is thus clear that good behaviour depends to some, or even to a large, extent upon the integrity of certain nerve cells in the brain—a problem for the moralist.

Unfortunately, there is yet no specific treatment for sleepy sickness, and the patient often has to spend years in a special hospital.

Meningitis

The brain is covered, as is the spinal cord, with three skins or membranes, called the meninges—one thick, the dura mater; and two thin, the pia mater and the arachnoid. The last two are the ones especially affected in meningitis or inflammation of the meninges. Meningitis may be caused by a variety of germs, two important microbes being the tubercle bacillus and the meningococcus. Meningitis may also occur as a complication of pneumonia, of typhoid fever, and of septic conditions.

The symptoms are headache, vomiting, delirium, and fever, with paralysis varying in situation according to the part of the brain which bears the brunt of the attack. The neck is often stiff, and in extreme

cases the back is arched. Diagnosis is made by examination of the cerebro-spinal fluid, in which an excess number of cells will be found, together with the germ causing the infection.

There is unfortunately no cure for tuberculous meningitis, which is invariably fatal. Some relief, however, can be given by periodically draining the cerebro-spinal fluid by means of lumbar puncture. In meningitis due to infection with the meningococcus, drainage of the cerebro-spinal fluid combined with injections of an anti-menginococcus serum has reduced the mortality from this grave disease (see section on germ diseases). Recovery from the actual disease is often marred by nervous complications that persist throughout life, such as deafness, blindness, paralysis, epilepsy. Another thing that may happen is that free drainage of the cerebro-spinal fluid is interfered with, so that it accumulates in the spaces of the brain. This condition of 'water on the brain' is known as hydrocephalus.

Syphilis of the Nervous System

One of the most appalling features of syphilis is that, unless it is properly and perseveringly treated at its beginning, the infection lurks in the body for years, often to break out later in its most hideous forms. General paralysis of the insane, one of the worst manifestations of syphilis, may afflict a patient as long as twenty years after the initial infection. That is why it is so important for the individual who contracts syphilis to carry out faithfully in every detail the instructions of his doctor. Treatment must be prolonged, and, inevitably, it is tedious and irksome.

Syphilis is a common cause of nervous diseases. It may attack any part of the brain or spinal cord, or their coverings, the meninges. Fortunately, the doctor has in the Wassermann reaction an excellent test for the detection of syphilis, and when the nervous system is infected certain characteristic changes in the chemistry of the cerebro-spinal fluid make it possible for him to clinch his diagnosis. This is important, for even in the late stages something can still be done for the patient, and prompt treatment may arrest the progress of this destructive malady.

As syphilis can attack any part of the nervous system, other diseases of this system may be mimicked, and a variety of misleading symptoms and signs be found. This mimicry often presents difficulties to the physician. On the other hand, there are two typical disorders, both comparatively simple of diagnosis, general paralysis of the insane—known as G.P.I.—due to syphilitic infection of the brain; and tabes or locomotor ataxy, due to a similar infection of the spinal cord.

The former, G.P.I., first makes itself known by mental and moral

Photo by Herbert Williams

SEX DIFFERENCE IN MUSCULAR FORM—MALE

changes in the sufferer. The business man becomes reckless in his dealings; the good father and husband turns against his wife and his children; the virtuous man takes to drink and immoral courses, and so on. Later there come confusion of speech, loss of memory and concentration, delusions of grandeur—a bank clerk may imagine himself to be the Pope or the King of England—and finally death following paralysis and disintegration of mind.

Early in the disease, tremulousness of the lips and of the hands and alterations in the pupils of the eye will put the physician on to the right track, and if the disease is diagnosed early much can be done in the way of treatment. It has lately been found that if a patient with this disorder is deliberately infected with malaria, considerable improvement may be secured. This is one of the modern curiosities of medical therapy.

In locomotor ataxy the germ of syphilis infects the sensory nerves as they enter the spinal cord, particularly the sensory nerves from the legs. The end result is that the brain is, so to say, cut off from the legs. It no longer receives the sensory impulses from the muscles, the tendons, and the joints which inform it what the leg is doing and where it is. The result is that walking becomes a chaotic and uncontrolled affair. The patient steps with his legs wide apart to prevent himself from toppling over, and has to keep his eyes glued on the ground in order to keep some sort of direction. If he shuts his eyes he will fall over. This same inco-ordination is observed in the arms and the hands. Paralysis of the eye-muscles frequently occurs, and sometimes blindness.

One of the earliest symptoms is pain over the joint surfaces and bones, as, for example, over the shin-bone. The pain, which precedes the paralysis by some interval of time, is often referred to as 'lightning' in character. It may be just a niggling or a severe pain, and, characteristically, it is repeated in a succession of jabs at one particular place in a given bout of pain. As the disease gains ground, a whole host of symptoms and signs proclaim its presence. Often enough the germ has attacked other parts of the body as well, notably the heart. In the early stages, when the main features of the disorder and the paralysis have not yet appeared, the doctor may be able to do a good deal for his patient by instituting vigorous treatment. Undoubtedly a periodic overhaul by a doctor would lead to the early discovery of many maladies, grave, often enough, only because they have gone on too long. There is one safeguard. If in doubt about yourself ask the doctor.

One of the worst features of this dreadful disease is the fact that the children of parents, either one of whom has syphilis, may be infected before birth; and mental deficiency, or G.P.I., or tabes, may destroy their chance of living the life of a human being.

Haemorrhage in the Brain

In syphilis of the arteries and in arterio-sclerosis, or hardening of the arteries, the blood-vessels may become so narrow that the blood clots within them. This will cut off the blood-supply and nourishment from the part of the brain supplied by the vessel, and softening of the brain will result. Often the softening takes place in the part of the brain which governs muscular movement, and paralysis of half the body occurs. These diseases of the arteries also weaken their walls, and when high blood-pressure is present the walls may give way, and a haemorrhage into the brain take place.

Tumours of the Brain

Tumours in the brain may arise there as new growths, or they may be secondary to tumours, such as cancer, elsewhere in the body. They give rise to various nervous disturbances (paralyses and fits) according to their situation in the brain, and in addition to these special local signs there are the general symptoms of headache, vomiting, and drowsiness. The only treatment is removal of the tumour by a surgeon, an operation that is exceptionally difficult, and not always attended by success. Great advances, however, have been made during the last few years in operations on the brain and the nervous system generally.

Epilepsy

Convulsions in childhood are not uncommon in conjunction with teething, and at the onset of infectious fevers. Epilepsy may be defined as a condition in which there are sudden and recurring disturbances of the function of the brain. A number of conditions may cause this, such as tumours of the brain, kidney disease, rickets, high blood-pressure, heart disease, chemical poisons, or actual injury to the brain. There is, however, a group of cases in which no obvious causal relation can be established, the epilepsy seeming to be the expression of some general bodily or psychological disturbance. Epilepsy manifests itself in what are often described as minor and major attacks or fits. In the major attack the patient frequently has some warning of its onset. If he is standing he falls to the ground with a cry, his arms and legs rigid, and his head and body arched backwards, the face becoming blue. After a few seconds the muscles begin to jerk, and the body goes into convulsion. At the end of the attack the patient is unconscious and passes into a deep sleep. When coming, so to say, back to life again, the patient may perform automatic—and even criminal—acts, over which he has no control. (One patient proceeded

to undress in the stalls of a theatre.) An attack rarely lasts longer than two minutes. In minor attacks of epilepsy, the spasm or convulsion is inconspicuous or absent. There may be only a slight and temporary loss of consciousness, as if a veil had been lightly and swiftly drawn across the mind; or the patient may suddenly fall to the ground; or there may be local spasms of different parts of the body, or hallucinations of sight, hearing, smell, or taste. These minor fits may be of no significance, passing off at puberty, or they may lead to progressive mental deterioration. They are just as likely to result in automatic unconscious actions as are the major attacks; a fact which is frequently referred to in the criminal courts.

No parent could miss the significance of an obvious convulsion, or would hesitate to take a child so affected to a doctor. But when the child merely has 'queer turns,' domestic remedies are sometimes relied on. This is inadvisable, for careful treatment by a physician can do much for the patient.

Migraine

Migraine is a condition which some think is related to epilepsy. It is quite common, and sufferers from this complaint are often supernormally intelligent. In migraine there are periodic attacks of 'sick headaches.' Severe headache, often confined to one half of the head, is usually preceded by some disturbance of vision, and followed by vomiting. There may be just mistiness of vision, or 'spots on front of the eyes,' or even temporary blindness. Most peculiar of all is a vision of brightly coloured zigzag figures, though these extreme visual disturbances are not common. The paroxysms of headache can be very distressing, and any one who is afflicted in this way should seek medical advice, for some cases respond well to treatment.

Chorea

Chorea, or St. Vitus's dance, is typically a malady of childhood; though there is also a form which attacks adults. Chorea in children is really a rheumatism of the brain, and these unfortunate patients often have a rheumatic heart. In its fully developed state the disease shows itself in the form of irregular and purposeless spasms of the limbs and of the muscles of the face and the trunk. These chaotic and uncontrollable movements may be confined to one half of the body. Before they appear in full force, the child becomes anaemic, irritable, restless, quick to cry. He often drops things. At school he may be accused of being troublesome and inattentive. A sudden change in a child's

behaviour at home or at school is nearly always an indication that a visit to the doctor is necessary. The treatment of St. Vitus's dance usually includes prolonged rest in bed.

TICS

Quite different from the inco-ordinated movements of chorea are the isolated, repeated, spasmodic movements known as tics. They may be a repeated blinking, or twitching of the head, or shrugging of the shoulder, or a combination of such movements. There is always something compulsive about them, and it is as if some inner tension were released by their performance. The affected child should not be scolded or punished or exhorted to make an effort of will to overcome these impulses. He should be taken to a doctor for a general overhaul. Reforms in diet, hygiene, etc., carefully carried out, and combined with a little common-sense psychology, will usually put things right.

The various craft palsies, such as writer's cramp, yield but little to treatment on ordinary lines, and some form of psychotherapy is nearly always needed.

DISSEMINATED SCLEROSIS

This is rather a ponderous name (as are so many of the names of nervous diseases) for a serious though not very common condition. Its cause is not known. Patches of inflammatory thickening appear in different parts—hence the name 'disseminated'—of the brain and the spinal cord. In the end the patient becomes paralysed. In the early stages of the disease there are transient weaknesses of a leg or an arm, or a temporary loss of sight; later on, disturbance of speech and a tremor of the hands often precede the final paralysis. The disease may progress, with periods of improvement, over a number of years. There is no specific treatment, but various therapeutic measures may give relief.

CEREBELLAR DISEASE

There are a number of rare congenital disorders of the cerebellum, and some acquired ones, which are characterized by gross disorders of movement of gait and of speech. It is as if the muscles did not know what they were doing or how to do it. It is unnecessary to point out that here, as in all such grave diseases, expert medical opinion must be sought.

The Spinal Cord

The spinal cord, like the brain, may be damaged by inflammation, by tumours, by injury (fractures of the spine, for example), or by certain degenerative processes. According to the extent of the damage and of its position, there will be loss of sensation and of movement (paralysis) in the parts of the body the nerves connected with which end in or pass through the damaged area. In tuberculosis of the spine, or in cases of fracture or of tumour, the surgeon can often effect brilliant cures.

In some diseases of the spinal cord the exact causes of which are unknown, the first changes to be observed are wasting of the muscles of the hand. Progressive muscular atrophy is one of these, in which there is a steady destruction of the motor-cells of the cord. Syringomyelia, in which cavities appear in the centre of the spinal cord, is another. Amyotrophic lateral sclerosis is another. The same kind of wasting of muscles occurs when, as occasionally happens, an extra rib grows from the spine at the base of the neck, and presses on the big nerve-roots leaving this part of the cord to enter the arm. This deformity can be remedied by operation. A degeneration (called subacute combined degeneration) of certain tracts of nerves in the spinal cord occurs in pernicious anaemia, with paralysis of the legs.

Peripheral Nerves

So far we have been considering diseases which attack the central nervous system—the brain and the cord. Affections of the nerves after they have left the central organization and have passed to the periphery are, however, more common.

Cranial Nerves

The seventh nerve to leave the brain supplies the muscles of the face, the muscles of expression. Inflammation of this nerve where it leaves the skull to enter the tissues of the face is comparatively common. The result is a paralysis of one side of the face, which looks flat and expressionless. The eye on that side cannot be closed, and the face appears drawn over to the healthy side. This paralysis is preceded by pain below the ear, and there is generally a history of exposure to cold. With adequate treatment cure nearly always follows, and complete power is restored. In the rare instances in which paralysis is permanent, being perhaps due to disease of one of the bones of the skull, a brilliant operation has been devised to restore function to the diseased nerve, and so to the paralysed muscles.

There is an obscure disease, known as Menière's disease, of the eighth cranial nerve, the nerve of hearing and balancing (see balancing mechanism in physiology section). This malady is characterized by sudden attacks of buzzing noises in the head, and intense dizziness, so that the patient often falls to the ground. Deafness also develops. Although far from certain, treatment is sometimes successful.

The fifth cranial nerve conveys ordinary sensation from the skin of the face. A very distressing malady of middle age occurs in which paroxysms of pain, becoming progressively worse, attack the face—usually one side. These attacks are associated with convulsive spasm of the muscles of the face. Trigeminal neuralgia, or tic douloureux, as it is called, imposes a great strain on the patient's endurance. Ordinary methods of treatment frequently fail to give much relief, and the advice of a nerve specialist must be sought. Injections of alcohol into the nerve are often resorted to, in order to alleviate this often agonizing complaint.

Neuritis

Neuritis means an inflammation of nerves. Inflammation sometimes attacks the big nerve trunks of the limbs with rheumatism. The affected nerve trunks in association are swollen and pink. The tension of this swelling gives rise to the severe pains of neuritis.

In the arm, brachial neuritis, to give it its proper name, starts suddenly and is accompanied with pain, frequently very severe, in the shoulder-blade, the arm-pit, and along the arm. The nerves themselves are tender if pressed on or stretched, and there may be some wasting of the muscles. In neuritis of the nerves of the neck, there is pain and stiffness of the neck and the upper part of the shoulder and the base of the skull. The nerves that pass between the ribs may be inflamed—a condition called intercostal neuralgia.

In the leg this inflammation is common in the big sciatic nerve which runs from the buttock down the back of the leg. The pain of sciatica (neuritis of the sciatic nerve) is often excruciating, and walking may become impossible.

Every case of neuritis (neuralgia simply means pain of nerves) needs investigation by a doctor in order to exclude serious disease of the nervous system and for proper treatment. Home-made remedies are best left alone.

Polyneuritis

There are certain conditions in which there is a widespread inflammation of the nerves, and of these poisoning by lead, arsenic, and alcohol are the most important. Polyneuritis also occurs in diphtheria and

diabetes. Paralysis of the muscles of the foot, causing foot-drop, and of the wrist (wrist-drop) are common symptoms. The investigation and treatment of these cases is not a simple matter, and demands the prolonged application of medical knowledge and skill.

TETANY

Tetany is a condition in which there are painful cramps of muscles and a heightened excitability of the motor and sensory nerves. It occurs in a number of complaints, and is essentially due to an upset in the calcium balance of the body tissues and fluids; too little calcium may result in tetany. Calcium metabolism is controlled by the parathyroid glands (q.v.). Tetany can sometimes be cured by the administration of calcium, or extract of parathyroid gland. The muscular spasms usually affect the hands, the feet, and the face.

XVIII—THE MIND DISEASED

THE mind is such a delicate structure that its equilibrium is very easily disturbed. In consequence of this, mental illness of one sort or another is extremely common. The ills which affect the mind range from the very mildest neuroses, which are practically universal, to the most serious and incurable cases of insanity. We will take the most important mental disorders one by one and describe them, and then we shall refer to what is known as mental deficiency or weak-mindedness.

THE NEUROSES

To begin with we must consider what are called the neuroses. These are relatively mild mental disorders, and the person suffering from a neurosis has not lost his mental balance, and cannot be termed insane. The popular diagnosis of 'neurasthenia' means that neurosis is present, but does not explain what kind of neurosis. The commonest type of mild disorder is known as obsessional neurosis. The symptoms of this complaint are varied, and they are so common that they are very often not recognized as signs of illness at all: but merely as a part of our normal life. Many people are afflicted with a desire to walk in certain ways on paving-stones and they feel uncomfortable if something prevents them from doing this. The famous Dr. Johnson is said to have had a feeling that he had to touch the top of every upright post that he saw. Some people feel that they must record the number of every motor car which passes. Others must wash and rewash their hands although they know they are clean. Nearly every one has his own pet series of rituals and prohibitions of this kind and, provided that they do not interfere with his normal social life or work, these traits are harmless. Rather more serious is the inability to make decisions. This is a form of obsession. Two courses of action may seem equally reasonable, and the individual may be unable to decide between them. Such a state of affairs can be quite normal but, with some people, every decision in their lives involves the same difficulty. They invent all kinds of absurd reasons for and against every course of action. Such people are only able to carry things out when doing them according to some sort of rule. The people who find it difficult to decide are often the same as those who, when they decide to do the right thing, do it for the wrong reason. They cut the knot instead of untying it. People

who suffer from thoughts which they cannot get out of their heads, and which occur at inopportune moments, are suffering from a form of obsessional neurosis. Recurring doubts about past actions can also be obsessions, as when a woman while she is out shopping cannot remember whether or no she has locked the back door. All these symptoms have one thing in common, that they conceal some fear or anxiety. If a person is stopped in the middle of an obsessional ritual, a state of anxiety develops. The thought which comes into the mind is: 'If I do not do this, such and such a disaster will happen.' The indecisive type of person fears unreasonably the consequences of making a decision either way, and the person who suffers from obsessional thoughts fears that he will give voice to these thoughts on an inopportune occasion.

While obsessional neurosis is most usually found in men, hysteria, the other common type, is more characteristic of women. Mild hysteria, in fact, is so common that it is almost normal, and may even make a woman who suffers from it more attractive. The hysterical reaction is the very reverse of an obsession. Here, instead of an interference with thoughts and actions, there is an interference with the internal functions of the body. A severe kind of hysteria causes paralysis, for which the doctors cannot find any physical reason. This is because the paralysis is of mental origin: it expresses a subconscious wish to avoid walking or moving in a particular way. A common type of hysterical reaction is sickness at the sight of something unpleasant. A headache which comes on when there is something unpleasant to do is often of similar origin. Almost any part of the body can be affected by hysterical derangement. Some forms of asthma are hysterical, and so also sometimes is sudden acceleration of the heart. Common and mild forms of hysteria appear in emotional states which do not seem appropriate to the circumstances, such as laughing and crying for no apparent reason. Hysterical blindness and deafness also occur; and so, occasionally, does what is known as a hysterical fit, which is really a violent emotional outburst. The hysteric requires an audience, and it is seldom found that a serious attack occurs when no one else is present. This is an important point in deciding whether a bodily disorder is hysterical in origin or not. There are also hybrid neuroses which are a mixture of hysteria and obsession: the outstanding symptoms of these being stammering and tics, or 'habit spasms.' They often cause less real disability than they appear to do, and are more troublesome to the onlooker than to the possessor. They are difficult to treat, but are sometimes influenced by suggestion.

There are other types of neurosis, one of these being unaccountable fear. Sometimes attacks of fear come on when the person is in a special situation. Some people cannot bear to be inside an enclosed room or inside a tunnel. Others are exactly the opposite: they cannot bear

to be out in the open. A good example of this is the case of a man who, after working for many years in an office, suddenly found that he became terrified when he was in the street on his way to work. He used to sidle along the wall when walking along the pavement, and then make a dash across open spaces. The quality of his work remained at a high standard, but eventually he was forced to stay at home owing to this fear. Fortunately phobias are some of the most easily curable of the neurotic manifestations and, in this particular instance, the man was completely cured after a few months of psychological treatment. Obsessional neurosis is difficult to cure, whilst hysteria takes an intermediate place in this respect. It is very often found that a change in mode of life has the effect of curing a neurosis, at least temporarily. The symptoms may be brought on by the presence of particular persons or particular situations, and a change in these will effect a temporary improvement. The roots of the trouble, however, lie in associations formed in early childhood, and it is only when these are remembered, and readjustments are made, that the symptoms are cured. The neurotic is a person whose emotional development has been interfered with. As already pointed out, childish traits sometimes remain in the adult mind. The fears, the indecision, the dependence on being told what to do, and the emotional outbursts, are all natural in children. Fortunately, with their other childish traits, many neurotics retain a considerable degree of suggestibility, and hence the value of suggestion as a therapeutic method in certain cases. Most neuroses, however, can only be cured by painstaking analysis by a highly trained specialist, and the treatment must last over a prolonged period of months or years.

Some forms of neurosis are so severe that they may almost amount to insanity. One very important illness is addiction to drugs. It is not the drug that makes people mentally ill in these cases: they are already ill before they start taking it. It is fairly safe to say that no one who is thoroughly well balanced in mind to begin with will become a drunkard or an opium addict. Behind these actions, which have something in common with severe obsessions, are deeply hidden impulses whose paths it is very difficult for the doctor to alter or even to discover. If it is remembered, however, that the drug-taking is only the external symptom, and that the real disease hides behind it, such people can be encouraged to have treatment early, before the habits are too far advanced and the physical health is too profoundly undermined.

EPILEPSY.

One other serious form of neurosis which should be mentioned is epilepsy. The epileptic suffers from periodic loss of consciousness, which may be of very short duration, or which may develop into a fit with twitching and foaming at the mouth. The people who suffer from

severe fits are not necessarily the worst cases. Doctors can provide drugs which will modify fits or prevent them, and the person may be quite capable and normal in the intervening periods. Instances are known in which a person has had just one epileptic fit in his life. Such instances show that it is not always necessary to take a gloomy view of epilepsy. In many cases, however, a deterioration of the mind occurs during the course of a number of years in which fits occur, and altogether the condition is very disabling. No epileptic, for instance, should drive a motor car. The onlooker can render service to a person in a fit by preventing him from falling down and injuring himself, and also by seeing that his mouth is kept open and his tongue, if necessary, drawn forward to prevent suffocation during the period of unconsciousness. Fits are precipitated in an epileptic person by certain causes, and these can be guarded against: two of the common factors are emotional excitement and constipation. The treatment of convulsions in infancy, which are regarded by some people as a form of epilepsy, is similar to that of fits in the adult or adolescent. Fits in infancy sometimes mean that the child is going to be an epileptic subject, but this is by no means always the case: the infant is very much more liable to convulsive seizures than is the adult, because of its incompletely developed nervous system. They may be caused in the infant by bad diet or acute illness, and, on the child's recovery from the general ill-health, the fits often disappear for good.

Sexual Perversion

Before going on to talk about insanity proper, we must refer to the disorders known as sexual perversions, in which the sexual instinct is directed away from its normal object. These peculiarities take an intermediate place between neurosis and insanity. An individual can, for example, be attracted towards members of his own sex much as other individuals are attracted to the opposite sex. This condition is known as homosexuality. A person who is, in this sense, perverted may lead a very unhappy existence: not only is he liable to the severest condemnation from the rest of society but, on account of the difficulty, or impossibility, of realizing his sexual desires, he is very liable to develop some mental disorder of another kind, ranging from mild neurosis to certain types of insanity. Most normal people view the desires of a person who is homosexual with abhorrence and disgust, and it is this attitude which is one of the most potent causes of unhappiness in the life of the homosexual. There is, however, good reason to believe that every one is, to some extent, homosexual: that is to say, their sexual feelings are not entirely confined to either men or women. Usually, in normal people, the balance of these tendencies is arranged so that

only the attraction towards the opposite sex is consciously felt. If we could realize that we all have these homosexual leanings, though we may not be conscious of them, we should be more tolerant in our attitude towards the person in whom the balance of instincts is in a direction different from our own. To be sympathetic and tolerant towards these unfortunate people may prevent them from having serious mental breakdowns. The homosexual, after all, need not be an abnormal person in any other way. The sexual instinct can be perverted in other ways. Some people are sexually stimulated by the thought of inflicting pain on other people, or even on themselves. A mild degree of perversion of this kind is not regarded as very abnormal. In severe cases these perversions lead to strange crimes of violence or to self-inflicted injury.

Insanity

So far we have been dealing with the neuroses or minor forms of mental disability and the perversions: now we shall proceed to describe the major forms which amount to insanity. The main difference between a person who is merely neurotic or neurasthenic and one who is insane is as follows. In neurosis the person feels that his illness is an affliction and desires to be rid of it. He recognizes neurotic ideas and behaviour as disturbances which interfere with his personal relationships and his work. A person who is insane does not usually feel this at all. He prefers the world of his own ideas and feelings to the external realities. He loses the love for other people, and the interest in external objects which is felt by ordinary people, to such an extent that he prefers his own imaginative pictures to these normalities. Thus a state of affairs may develop in which a person's thoughts are at variance with obvious facts. A person in such a state is said to be deluded.

It is very difficult to cure an insane person by any form of therapy which involves confidence in the physician, because the patient cannot co-operate sufficiently. There exist types of insanity, however, which are known to be curable, and these types are due to poisons in the system which affect the working of the brain, and consequently throw the mind off its balance. These diseases are treated through the body by chemical and physical means. A person who is under the influence of a heavy dose of a drug (it may be even of alcohol, as in delirium tremens) is, for the time being, insane, but he recovers as soon as the disturbing effect of the poison is removed. The most important kind of insanity due to poisoning is known as general paralysis of the insane. This insanity is due, in the first instance, to the venereal disease, syphilis. The microbe of syphilis works slowly, with the result that insanity only develops many years after the original infection (which often has

long been forgotten). It is most important to know the early signs of general paralysis because, in cases where the disease is taken in hand early, it can be cured: whereas, if it is left without treatment, it invariably proves fatal within a few years. Among the early signs of this type of insanity are ideas of self-aggrandizement which are quite out of proportion to the actual circumstances. For instance, a clerk in an office, after working well for many years, begins to say that he is much too clever to be doing this work: at the same time his work begins to deteriorate. Further, he will tell everybody that he is immensely rich, that he is a magnificent athlete, that he is an intimate friend of high personages, or that he has had marvellous adventures. At the same time it will be apparent to those around him that he is becoming ill and increasingly careless as regards his dress and his behaviour. When these mental signs are present, medical aid should be sought at once: a doctor will be able to detect incipient nerve-paralysis. In the later stages, when the paralysis is advanced, and the mental powers have been weakened, there is little prospect of improvement.

A delirium which complicates the course of an acute fever, or follows childbirth, is a true form of insanity, but its treatment is the same as that appropriate to the physical illness which causes it. The patients recover as soon as the poisons which are responsible are removed from the system. In all the mental illnesses which are due to poisons the most noticeable change in the mind is a confusion of the thinking powers. In the types of insanity which are not easily influenced by medicine the disorder of one of the other mental functions is most noticeable.

Delusional insanity is a good example of one of these other types. It is an insidious condition, which may come on at almost any time in adult life, in which the person feels that he is persecuted. He may think that his friends are turning against him, or that people he has never met are spying on him, staring at him in the street, or conspiring in secret to do him harm. A stray paragraph in the newspaper is thought to make a veiled reference to him. He thinks the Freemasons or the Jews are plotting to ruin him. He considers an inoffensive, everyday remark by his wife to be evidence of her infidelity. Coupled with these ideas may be more serious delusions: he may imagine that his body is full of electricity, that his food is poisoned, or that he is exceedingly powerful and responsible for ruling over a large area of the world. It is not uncommon for people with delusions like these to go to law about absurd things, such as claiming to be the rightful heir to the throne. They are nearly always complaining of bad treatment. On the other hand, they do not lose their intellectual ability, and this fact makes them all the more difficult to deal with, for they cannot be argued out of, or persuaded away from, their false ideas. The following

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remarks were made by a lady who was a typical case of this kind, and who had been for some years in a mental hospital. 'I don't consider myself a patient here, because they can't treat me. It 's I who treat them. The superintendent said I was mentally ill. I cannot understand how he could use such a word, and I am sure he is sorry now for having said it. The fact is I 'm too well to be released.' She believed that she could confer on people a divine power. Delusional insanity is rather infectious and, if people do not recognize that a person with such ideas is insane, they may be led into believing in the same things themselves. Some people suffering from ideas of persecution are able to carry on their life in the general community, and it is very important that the nature of their ideas should be recognized by people around them, so that subtle, and often libellous, fallacies may not be broadcast through the community.

DEMENTIA PRAECOX.

A still more severe type of insanity is known as dementia praecox, and, in this case, although the intellect as well as the emotional outlook suffers, the main cause is a disturbance of the desires. A person suffering from dementia praecox withdraws himself completely from the real world, because he desires a different one, and he builds it up anew in his imagination. Very often the sufferers from this disease invent new words, or even whole languages, which are entirely for their own use, and whose meaning it is very difficult to discover. Their speech has been described as being like a 'word salad.' Often it consists in endless repetition. Here, for example, is what one patient wrote: 'For we ourselves can always hope that we should let ourselves pray other thoughts, For we ourselves wish to wish to know who would let the swine's head be tormented to death with us foolishly. No, we ourselves . . . etc.' These individuals act in peculiar ways, and their motives are impossible for the onlooker to grasp. On the whole their conduct is most easily described as a return to an infantile state, which return has taken place because the driving force of their instincts has not been sufficient to enable them to face the problems of adult life. The commonest age of onset is between twenty and twenty-five years. The disease is progressive, and eventually leads to a profound state of dementia, in which the patient sits muttering to himself, conversing with imaginary voices. Individuals suffering from dementia praecox constitute a danger to the community because they may commit crimes of a serious character for reasons known only to themselves, for they obey only the laws which suit the dictates of their own peculiar wishes. Even if recognized early, dementia praecox cannot be cured, though spontaneous improvements occur.

MANIC-DEPRESSIVE INSANITY.

Another type of mental disorder is associated mainly with disturbances of feeling and emotion. This disease is called manic-depressive insanity, and takes the form of attacks of mania or depression, or of an alternation between both states. People who suffer from this disease usually have quite long periods of months or years in which they are free from it. A state of mania consists of heightened activity associated with a feeling of well-being. A maniac appears, at first sight, like an excited person who is slightly intoxicated, but his actions soon show that the disturbance is much more serious than this. Outbursts of violent passion occur at the slightest provocation and, underlying the increased rapidity of thought and action, is an angry emotion directed against every one and everything in the vicinity. Maniacs sometimes have a brilliant capacity for wit, and can talk in rhyme without premeditation. A woman patient, on being admitted to a mental hospital and seeing the doctor, at once exclaimed with extreme rapidity: 'You are a king, you ought to be a clown: I am a queen, and I 'll knock you all down.' The state of depression is exactly the converse of mania. In a state of melancholia, or deep and prolonged depression, a person acts very slowly. His thoughts seem clogged: he is weighed down by feelings of unworthiness and guilt in respect of crimes he has never committed. He wishes he were dead and sometimes even says that he is dead. He usually refuses food. The underlying motive in melancholia is hatred turned against the self, and suicides are common in melancholic subjects. It has been said that every melancholic is a potential suicide, and that every maniac is a potential murderer. It is therefore quite obvious that a person in a condition either of melancholia or of mania needs immediate medical care, so that he can be prevented from doing damage to himself or others until the attack has passed off. The manic-depressive patients do not lose quite so much of their sense of reality as do the sufferers from persecution mania or dementia praecox, and they are more capable of recovery. Thus it is the duty of the onlooker to see that appropriate medical care is administered to them. A mild degree of maniacal excitement can occur in normal people, and the increased energy may express itself in a capacity for witty talk or brilliant work. It is also quite normal to feel depressed from time to time, and the retarding influence on thought and action is obvious. However, it is some consolation to know that, in the normal individual, such states of depression are only of short duration. In elderly people, whose bodily and mental machine is beginning to wear out, attacks of depression may last longer.

Mental Deficiency

We now leave insanity and turn to the question of mental deficiency. This is a subject about which a great deal is often said by people who know very little about it. Its problems are not easy to understand fully, but their outlines are easy to grasp. People who are mentally deficient belong, roughly, to one of two types. The first of these types consists of people who are slow-witted and who, consequently, lag behind their fellows in school work and find it difficult to manage their affairs or obtain employment when they are grown up. The dull people do not form associations quickly; but many retarded and dull individuals are really just as normal as are clever people. Not everybody is of the same physical stature: some people are short and others tall, while the majority are of medium height. Similarly, although most people are of medium mentality, a few are poorly endowed, and some have extra ability. The dull children need special care in their education, partly because they are often better at working with their hands than with their heads. If they are given suitable training when young they will be able to occupy themselves happily and usefully in later life. Their early training has additional importance because such children are very susceptible to bad influences. They are much more likely to get into trouble than are children of average intelligence and, if they commit crimes, such as petty thefts, they are more likely to be caught and brought up before a magistrate. Special schools have been created to provide the kind of education which is suitable for very dull children, but care and control in their moral education at home are also needed. When they are grown up, these dull people remain intellectually like children between the ages of seven and eleven, and they constitute a difficult problem to their parents and to society in general. Many of them can only be looked after in institutions because the necessary supervision of their conduct is not possible at home. In these institutions they are given training and are taught manual employments: there they have no responsibility, and plenty of recreation—games, concerts, cinema shows, and dances—and usually they are not at all unhappy. Some parents erroneously imagine that their dull-witted children will become normal when they are married: this is an entirely mistaken view. It is not good to encourage weak-minded people to marry, because they cannot manage a home properly, and they cannot attend adequately to the needs of their children. Parents of a child who is dull-witted should not hesitate to consult the representatives of such organizations as the Voluntary Associations for Mental Welfare. These societies exist for the purpose of giving advice to parents and of arranging for the proper education of all children whose mentality is below normal.

The second group of individuals who are classed as mentally defective

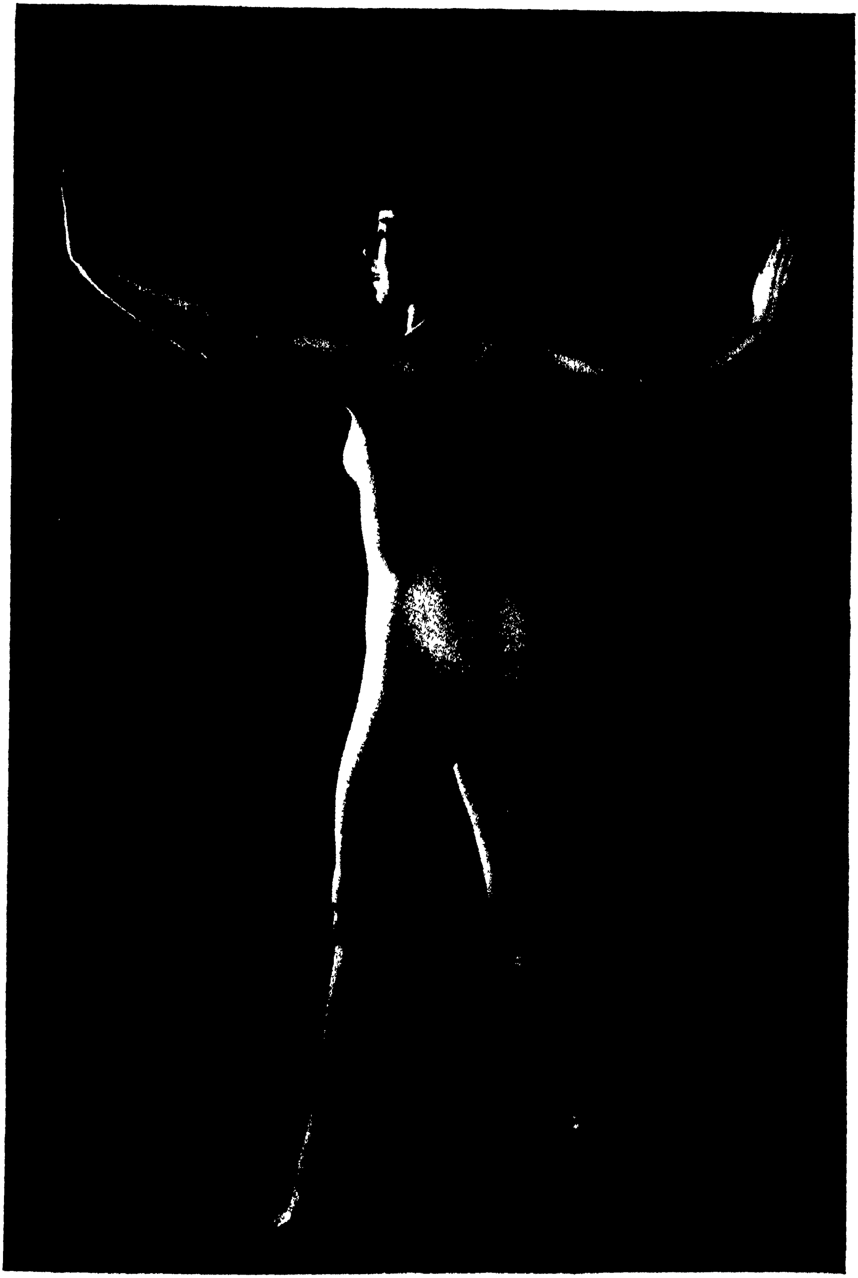


Photo by Herbert Williams

SEX DIFFERENCE IN MUSCULAR FORM—FEMALE

are the imbeciles and idiots. These are quite incapable of learning sufficient to enable them to earn their own living, or to become satisfactory citizens in any circumstances. In a great number of cases they suffer from some physical disease or deformity, and they may be so severely affected that they are incapable of understanding anything at all. Idiots of the lowest grade are quite helpless, and even have to be fed: though human, they are much less intelligent than other animals, and they require constant care and supervision. By far the greater proportion of imbeciles and idiots are incurable, and institutions where they can be looked after are state-provided. There is one exceptional disease, however, which causes imbecility, that is curable if recognized at the time it begins: this disease is known as cretinism, and has been described in an earlier part of the book.

The causes of idiocy and imbecility are very varied: some idiots being the result of the transmission of the venereal infection of syphilis from their parents, others being due to injury at birth, whilst certain infectious diseases of the brain, which may occur in infancy or childhood, have the same result. Falls or injuries in infancy very rarely cause mental impairment. A not uncommon type of imbecile, which is easy to recognize, is known as the mongol. Mongolian imbeciles are thus named because they appear to us like little Chinamen: this does not, however, imply that there is any Chinese blood in their families; indeed, they occur in all parts of the world. They are frequently found to be born at the end of a family when the mother is reaching, or has reached, middle age. If all mothers stopped having children at about thirty-seven years of age, nearly three-quarters of mongolian imbeciles would never be born. It is often supposed that idiots or weak-minded children are born to mothers who have had frights during pregnancy: there is absolutely no scientific evidence for this belief, which must be regarded as pure superstition. The causes of idiocy are just as definite as those of other physical diseases, and though, at present, it is not easy to say how to prevent idiots from being born, our knowledge on this subject is progressing.

It is generally supposed that heredity plays a large part in the causation of mental deficiency, and this is probably true. There are, however, not very many diseases which cause idiocy in which heredity can definitely be proved to be the only cause. The same applies to other mental disorders: there are a few kinds of insanity which are known to be inherited, but, in far the greater number of cases, the events which happen during the individual's life are the decisive factors. The main causes of insanity appear to be mental and not physical injuries, which occur in early life. These injuries to the mind, which may be sudden severe shocks or deprivations affecting powerful instinctive impulses, cause the thoughts to turn away from certain parts of

reality because they are unbearable. Any one who wishes to understand the outline of the process by which turning away from reality develops into insanity should consult such books as *The Psychology of Insanity*, by Dr. Bernard Hart (Cambridge University Press), and *Psychoanalysis*, by Dr. Ernest Jones (Benn's Sixpenny Classics). The injured mind fails to reach proper development, and easily breaks down when difficult situations arise in later life. Probably heredity enables some people to withstand shocks and deprivations better than others. Mental dullness or backwardness, like shortness of stature, is inherited to a considerable extent, but the manner of inheritance is very complicated, and it is unwise to make definite predictions about the mental development of children on the basis of the knowledge of the mentality of their parents or other relatives. At the same time any one who has a near relative who is insane or weak-minded would do well to consult a competent physician on the chances of his children inheriting the same disability. The answer can only be given in terms of chances, and individuals must then decide for themselves whether they will take the risk of bringing a new child into the world. It is obviously unwise for a person who is himself weak-minded or insane to have children, not necessarily on account of the danger of inheritance, but because it is unfair for children to be brought up with such a handicap.

XIX—STAMMERING AND CLEFT-PALATE SPEECH

Stammering

In order to form an opinion as to the most successful method of treating stammering, it is necessary to ascertain to what extent nervousness is responsible for the temporary breakdown of the complicated speech mechanism.

That nervousness plays an important part, is proved by the fact that stammerers can speak fluently when alone in a room; and for this reason many people have classed it as a nervous disorder to be treated on purely psychological lines instead of combining such treatment with lessons in voice production.

When we view stammering from another angle, that of voice production, we are faced with several undeniable facts. It is well known that stammerers who are musical can sing without any trace of stammer. Then, again, many actors who stammer in conversation have no difficulty when they are on the stage; also, there are army officers who stammer yet have little or no trouble when giving orders on parade. Lastly, stammerers can mimic people or dialects with absolute fluency.

These apparent inconsistencies can be explained when we realize that in all the above cases the stammerer is thinking of voice tone, whereas in conversation he is thinking of words. Let us take singing first, because it is the clearest example: the singer has nearly all his attention concentrated on voice tone, which has to be on a particular note, and to be held for a definite time; he leaves the words to find themselves.

The officer on parade subconsciously thinks of voice because he must shout in order to be heard, his mental picture of words is secondary. The same thing applies to the actor who subconsciously knows he must swing his voice to the back of the theatre.

The same principle applies to mimicry, because imitation of a person or dialect is only possible by imitation of the vowels, and it is in the vowels that the voice tone is heard.

Put into other words, the stammerer when singing thinks in terms of vowels, whereas when speaking he thinks in terms of consonants. All the difficulties of the stammerer can be overcome by concentration on the vowel sounds.

It will help us towards a clear conception of the correct balance between vowels and consonants to think how a child's speech is built up. Nearly all children stumble when learning the double and triple

consonants, as in *stand* and *strand*: every one has seen a little child jerk its head forward when attempting to say *splay*; in fact, the head movement is identical with that of the adult stammerer in difficulties. If, then, by 'stammering' we mean 'stumbling over words,' it must be admitted that 99% of children stammer when they are learning to combine consonants, but that nearly all of them are comparatively fluent by the age of six; out of the ninety-nine one fails to master the consonants, becomes conscious of frequent failure, and, by anticipating further failure, develops into what we call a nervous stammerer. In order to substantiate this contention let us think of the jerky speech of the average small child; note how the effort to form the consonants results in clipped vowels. Again, contrast the jerky speech of the child with the smooth-flowing voice tone as heard in singing.

The stammerer thinks of the word *difficult* as d-f-k-l-t, while the singer thinks of three notes on three vowels, i-i (as in *bit*) and oo (as in *foot*). There is a general failure to realize the close connection between speech and song: we often hear it said that 'A' has a bad speaking voice but a good singing voice. We are not bi-vocal: we have only one larynx, the voice-box out of which all voice tone comes, so the quality of the voice should be identical whether in speech or song, the only difference being in volume, pitch, and time value. A singer who is a real artist does not confine himself to tone production; he is master of that, and the tone production is, or should be, automatic; the artist singer thinks of his song and its meaning, and sings as he would speak so far as the time values of the notes permit.

The best singers sing as they would speak as nearly as possible, and the best speakers speak as nearly as possible as they would sing.

It is most important to realize that there are only two definite and clear differences between song and speech; in the former the pitch and time-values are fixed and clearly defined, in the latter there is almost infinite latitude. With regard to pitch, we must realize that a lot of modern teachers of elocution teach their pupils to sing when they should be speaking—it is singing when the pitch is clearly defined. In perfect speech the pitch of the voice should be changing all the time. Perhaps an illustration will help us. The larynx is used for song and speech; the differences between the two being pitch and time-values. The legs and feet are used for running and walking, the difference being that in the former both feet are off the ground at the same time, while in the latter the toe of the rear foot does not leave the ground until the heel of the forward foot is down.

The more closely the stammerer links up his speech with song the more quickly he will master his difficulties, which are all of his own making by the development of bad habits, the habit of over-stressing consonants and of clipping vowels.

The stammerer has got to concentrate on vowels, that is, voice tone, to speak slowly to allow enough time for full voice tone, to speak firmly to allow full play for voice tone, to speak evenly so that the voice tone may flow evenly as it does in song.

Since success in the treatment of stammering depends upon vowels, it is important to have a full knowledge of the vowel sounds used in what may be called southern educated English; there are twenty-four, eleven simple, ten diphthongs, and three triphthongs, and they are:

SIMPLE.

1. *ee*	as in	seat		6. *oo*	as in	foot
2. *i*	,,	pig		7. *o*	,,	hop
3. *e*	,,	leg		8. *ar*	,,	ark
4. *a*	,,	can		9. *or*	,,	cord
5. *oo*	,,	boot		10. *er*	,,	hurt

11. *u* as in cut

DIPHTHONGS.

1. *a*	and	*i*	as in	tale		6. *u*	and	*oo*	as in	loud
2. *e*	,,	*er*	,,	hair		7. *or*	,,	*i*	,,	hoist
3. *o*	,,	*oo*	,,	home		8. *i*	,,	*er*	,,	hear
4. *i*	,,	*oo*	,,	tune		9. *oo*	,,	*a*	,,	moor
5. *u*	,,	*i*	,,	night		10. *i*	,,	*u*	,,	beard

TRIPHTHONGS.

1. *i*	and	*oo*	and	*u*	as in	cure
2. *u*	,,	*oo*	,,	*u*	,,	tower
3. *u*	,,	*i*	,,	*u*	,,	fire

Some authorities state that there are thirteen vowel sounds; this number would be made up of the eleven simple and Nos. (1) and (3) of the diphthongs. All the other diphthongs and the triphthongs are made up of vowels which appear in the list of simple vowels. Since the correction of the stammering habit depends upon vowel study and vowel drill, I have given considerable space to their analysis and description.

Now it might seem that if stammering can be cured by mastery of the vowel sounds and by developing a habit of 'vowel speech,' success should be certain and speedy in 100% cases, but we have to turn to the other aspect of the trouble, the psychological side, and we find we are first of all up against the habit factor. It is no easy matter for a stammerer of twenty-seven, who has 'thought in consonants' for twenty years to change over suddenly and consistently to 'think in vowels.' That is what has to be done, and the sooner a start is made

the sooner fluency is reached. But we are not at the end of the difficulty yet, because a great many stammerers do not want to change over to vowel speech; they are afraid they will be conspicuous if they do, but they fail to realize that they are far more conspicuous with a stammer than with the perfect voice production of the expert actor or orator. The same voice production should be taught to the actor, the public speaker, and the stammerer; in the cases of the first and second it is an advantage, for the stammerer it is essential. The stammerer has to make a choice between perfect elocution and stammering: compromise is waste of time; the sooner a change over is made the sooner comes the control of vocal tone.

The ordinary form of stammering is nothing more or less than a cessation of vocal tone or a break in its continuity: the obvious remedy is to form the habit of an even flow of vocal tone. It is useless to try to avoid stammering; the stammerer has always done that; he must now study a smooth flow of tone because it is the best way to speak.

Another cause of partial success is that the stammerer is often lacking in the will to win; failures in the past and constant feeling of insecurity must result in an inferiority complex, but the best and most logical corrective is surely to build up confidence by the use of the right *voice tone* and *speed* to ensure success. If the stammerer will study and acquire a commanding tone of voice for its own sake, because it is the best way to speak, it is obvious that his confident voice will inspire him with confidence; this has been proved over and over again. Nothing is more calculated to overcome an inferiority complex than the knowledge that a habit of many years' standing has been overcome.

Again, there are stammerers who make use of their stammer to avoid meeting people; this may be due to shyness or a hermit complex, but it will save time to get the stammerer to make up his mind whether he really wishes to speak fluently or not. He should be asked why he wishes to be cured, and whether he is honestly doing all he can to cure himself. Many boys of school age avoid work under cover of a stammer. Some experts hold the opinion that 90% of stammerers who are below average in their school work make some use of their disability to avoid punishment for bad work. It is equally certain that a wealthy business man's son who is fond of games, and does not take too kindly to the idea of long office hours, will subconsciously delay his cure. In such cases it is better to insist on the young man going into the office for a year or so and then seeking advice and, if necessary, taking six months' leave to concentrate on the corrected voice production. Any one who makes up his mind to do so can learn to speak slowly and evenly on a firm tone of voice, and when this is acquired stammering is impossible.

The correction of stammering is merely a matter of elocution, but in this connection it is important to realize that many schools of

elocution pay very little attention to vowel sounds, which, as we have seen, constitute the all-important factor in the correction of a stammer. Many schools of elocution teach exaggerated formation of consonants, and all the rest of the training consists in a smattering of stage-craft. Provided that the elocution is based on voice production and vowel formation the stammerer cannot do better than seek the advice and help of such a teacher, but it cannot be too clearly emphasized that elocution of the average type, which teaches exaggerated consonants at the expense of vowels, will always increase the difficulties of the stammerer.

Many readers, having read so far, will say: 'This is all very well, but A's difficulty is in the consonants, he cannot say words beginning with t/d or k/g.' The fact remains that the difficulty is in the vowels, which 'A' has not pictured in his mind when speaking, although when he is singing his attention is forced upon them. If the real difficulty were in the consonants it would still be there when singing. *As long as the stammerer concentrates on vowels he speaks fluently.*

The ideal method is to practise two minutes in every half-hour, the object of the two minutes' practice being to 'tune in on vowels.' Having 'tuned in' the stammerer must try to go on speaking in the same way. The habit factor is so strong, after ten or twenty years of 'thinking in consonants,' that it is useless to keep the 'thinking in vowels' speech for the periods of practice or for use when faced with a breakdown. Slow, firm, and even all the time.

The habit of quick, jerky, over-consonanted speech, which we call stammering, can only be overcome by persistently building up a habit of slow, smooth, vowel speech. The moment the stammerer realizes this simple fact the remedy is in his own hands. If he can answer twenty questions fluently, practice will enable him to answer two thousand by the same method. The voice producer can only indicate the road and criticize the pupil, he cannot tread the road for the pupil. No one can cure a stammer except the owner of it! The voice producer can and does explain, illustrate, and encourage, but there his work finishes.

There is a widespread idea that incorrect breathing is the basic cause of the trouble, but there is little doubt that incorrect breathing is just one more bad habit which develops from the attempt to make sentences out of consonants. Any form of nervousness affects the breathing, but there is a far more direct cause than that.

When the vowel speaker or singer sounds a vowel he brings the vocal cords together, and thus forms a resistance to the breath which is forced up from the lungs by muscular action.

The stammerer lacks this automatic action of breath resistance, and the vowel sound, not having been mentally visualized, the cords do not come

together, and there is no resistance; at the same time the breath is forced up, with the result that it is all expended in a single second and no breath is left. The remedy is not to take a deeper breath, which only increases the trouble, but to set up a resistance by bringing the vocal cords together; the mental picture of the voice sound will always do this.

Stammering has often been described as a lack of co-ordination between the brain and the mechanism of speech. This is perfectly accurate, but it will not help the stammerer towards fluency any more than it will help you, if your watch stops, to be told that there is a lack of co-ordination between your watch and Greenwich time! I suggest that the stopping of your watch is caused by a broken mainspring. All the wheels have stopped and the hair-spring is motionless, but that does not mean that all the component parts of the watch are broken. Refit a mainspring and the watch will go again. The mainspring of speech is vocal tone; as soon as that is corrected, set going (by mental picture), and kept going (by the habit of smooth-flowing tone) the talking mechanism will work perfectly.

It is clear, then, that a stammer is really due to lack of automatic control of the voice-box, for which the logical remedy is to build up a conscious control by concentrating on the vocal tone in the vowels; gradually this conscious control will become automatic, just as any other muscular movements become automatic when they have been made several thousand times.

There is a very occasional type of stammer in which the sufferer stammers on the vowels as well as on the consonants. In such cases even closer attention must be paid to the time values of the vowels and the rhythm of words and sentences; the correction of the trouble will take longer, because there is no sure ground to work upon as in the case of ordinary stammering. In the usual type of stammer as soon as the stammerer is on vowels his difficulties disappear.

Every stammerer has a complete remedy within his grasp, and the price he has to pay for freedom from his disability is persistent and dogged practice on the lines described above.

Follow this advice. *Speak slowly, firmly, and evenly all the time :* slowly, because if a thing is worth saying, it is worth saying slowly, so that hearers may have time to take it in; firmly, because if a thing is worth saying, it is worth saying decidedly, as if you are sure of your statement; evenly, because if a thing is worth saying, it is worth saying beautifully with good rhythm as in song; all the time, because the real problem is to overcome a bad habit of long standing by patiently building-up a good one to take its place.

Cleft-Palate Speech

It is a common experience to meet with the dull, muffled voice tone associated with 'cleft palate,' even after successful surgical operation or the fitting of a satisfactory denture or both. The persistence of this tone is due to the fact that the average patient does not know how to take full advantage of the skill of the surgeon and dental surgeon. The muffled tone is caused by the flow of voice tone being chiefly through the nose instead of the mouth, as in a normal speaker. To correct this tone it is necessary to be able to keep a steady pressure of breath in the mouth; this pressure is controlled by the soft palate which shuts off the flow of breath or voice tone through the nose. Raising and lowering the soft palate to shut off the escape of breath and to permit it, is controlled by very rapid movements which are automatic. The nasal tone of the American is due to the fact that the soft palate is kept lower, and so allows more voice tone to pass through the nose. In the case of cleft palate the mobility of the soft palate is generally considerably impeded by scar tissue, and therefore needs special exercises to enable it to do its work normally, and to prevent the ultra-nasal tone.

In normal people there is a complete closure of the nasal escape in the formation of the consonants p/b, t/d, and k/g, but in cases of cleft palate there is an audible escape of breath through the nose which makes all the above consonants indistinguishable.

If the patient can puff out his cheeks a complete closure has been made, and the first and most important step has been taken, because any one who can puff out his cheeks is capable of normal speech. Blowing up toy balloons, blowing out candles at increasing distances, will increase the mobility of the soft palate, and the pressure of breath in the mouth by decreasing the escape through the nose. But it is very important for the patient, when doing these exercises, to think about the soft palate and its position, because ultimate success depends on linking up the exercises with actual speech, and particularly with the formation of the explosive consonants mentioned above.

Turning now to the consideration of the vowels, it should be realized that cleft-palate patients are, until they have been taught, always deficient in vowels and voice tone; the reason being that the consonants having caused abnormal trouble, attention has been concentrated on them at the expense of the vowels which actually offer no special difficulty. We are now really concerned with voice production, so all that is taught by a capable teacher of singing will be of value to the patient who has to develop vocal tone.

The first step is to open the throat fully by raising the soft palate as it is raised when yawning; this will increase the escape of breath and voice through the mouth, and decrease the escape through the nose.

Next in importance is the development of chest resonance, first because chest resonance is the most important factor in good tone production; and secondly, because good chest resonance will tend to cover any remaining abnormal nasal tone, i.e. nasal resonance.

A last point deserves special mention: a cleft-palate patient tends to speak disjointedly—that is, without the even flow of voice tone heard in the normal speaker. This habit is caused by the difficulty experienced when mastering the consonants, but it can be overcome by thinking of words, phrases, and sentences flowing evenly through the mouth in a steady and unbroken stream.

Whoever has a cleft palate will be well advised to seek the advice of an expert in voice production, firstly, because none of us hear our voices as others hear them, and it is therefore impossible to learn singing or correct speech entirely from a book; secondly, because the expert is likely to have had years of varied experience to help him to overcome special difficulties in special cases. It is a wise plan to seek such advice when the patient is about five years of age, so that the mother or nurse, under the guidance of the expert, can prevent the formation of bad habits. Then as the child grows up occasional supervision will enable speech to be developed on the correct lines.

The reader should study the preceding section on stammering because much that is described there in detail will help to make the basic principles of correct speech clear. Any one who has been treated satisfactorily by a surgeon or a dental surgeon or by both is capable of normal or very nearly normal speech if he or she will practise persistently on the lines described above.

XX—DISEASES OF CHILDHOOD

THE following pages contain a brief sketch of some of the commoner or more important diseases peculiar to infancy and childhood. The object has been rather to inform the reader of the possibilities of prevention or early recognition than to enter into a detailed discussion of treatment and complications. Frequently, indeed, treatment has been dismissed with the words 'get a doctor,' as being the wisest advice.

Many common diseases of childhood have been omitted as they differ but slightly from the same diseases in the adult.

Disease in the new-born child, a subject of the greatest importance, has been dealt with elsewhere.

RESPIRATORY DISEASE IN THE CHILD

The respiratory tract extends from the nose and mouth via the larynx or voice-box, windpipe or trachea, the bronchi, branches of the trachea, and smaller twigs of the bronchi to the lung tissue itself. Throughout the day and night, air, more or less laden with dust and germs, is passing to and fro over the mucous membrane lining this system of tubes, and it is not surprising therefore to find that it affords one of the commonest sites of infective disease in the child. When not itself the site of infection it acts not infrequently as a portal of entry for germs which pass to distant parts of the body, and work their mischief there. In this section, however, we are dealing solely with disease of the respiratory tract itself.

INFECTIONS OF THE NOSE AND THROAT

To counteract the results of constant exposure to air-borne germs, the nose and throat are equipped with an elaborate lymphatic system, with its associated lymph glands. Aggregations of lymphatic tissue occur at the back of the nose as the adenoids, and in the throat as the tonsils; their purpose is to capture and destroy germs settling on the mucous membranes of the nose and throat, and this they constantly do without showing any symptoms themselves.

TONSILLITIS.

When a large number of germs or an unusually virulent type of germ is captured by these masses of lymphatic tissue, a brisk battle results, accompanied by the symptoms of inflammation; in one word, tonsillitis.

Neighbouring glands in the neck may be involved in the role of reinforcements, and will in their turn become inflamed. In the outcome the tonsils and glands will overcome the infection, and the inflammation will subside. This may occur without permanent damage to the tonsils, in which case they will live to fight another day; but the tonsils may be so severely damaged by the infection that they cannot adequately resist subsequent infection. In this case the next invading germ makes its home in the weakened tonsils, and we have the state of affairs known as chronically septic tonsils; these are a constant source of infection and ill-health, and the tonsils are best removed.

The foregoing description of the conditions giving rise to acute and chronic infection of the tonsils is equally true of the adenoids, and indeed of tissues throughout the body. The chief difference is that whereas the chronically infected and useless tonsils and adenoids may be removed, other organs usually cannot.

Enlargement and disease of the adenoids result in mouth breathing, frequent colds, deafness through blocking of the Eustachian tube, and disease of the middle ear through infection passing up that tube, and chronic bronchitis. Vaguer symptoms, such as loss of appetite, fidgets, chronic ill-health, and dulling of the intelligence, are frequently attributed to adenoids; this may be the cause in some cases, but it is not uncommon to find no improvement after the removal of the adenoids.

An attack of acute tonsillitis is accompanied by a high temperature and great malaise. The tonsils are large and red and painful and may be covered by a coat of yellow matter. It is not always easy to distinguish at a glance between this yellow matter and the membrane of diphtheria. In all cases a doctor's advice should be sought. During the attack the swallowing of solid food will be impossible, and the child must be confined to bed, and given plenty of fluid to drink. Gargles or antiseptic tablets may be used, and the bowels must be kept free. The symptoms usually subside in three or four days. Continuance of fever beyond a week may lead to the suspicion of a quinsy, or abscess behind a tonsil, or an abscess in the glands of the neck.

After an attack of acute tonsillitis an operation for removal of the tonsils cannot be considered for at least six weeks. It is impossible in a shorter time than this to determine to what extent the tonsils will recover from the inflammation, while removal of the tonsils shortly after the attack is extremely dangerous and should never be done.

LARYNGITIS.

Laryngitis, or inflammation of the larynx, shows itself by hoarseness of the voice. In infants the cry is hoarse. The infection may arise primarily in the larynx, or may be part of a widespread respiratory infection, such as the common cold. Mild laryngitis is a sufficiently

common occurrence as rarely to occasion alarm; this is as it should be, but it is wise to remember that more serious infections can occur. The chief of these is diphtheria, which will be dealt with elsewhere. An acute laryngitis may herald the onset of measles.

A mild catarrhal laryngitis usually responds to resting the voice (in children not always easy of attainment) and to inhalations of steam impregnated with the vapour of friar's balsam. Small children should always be carefully supervised while inhaling steam, as bad scalds have resulted from neglect of this precaution.

BRONCHITIS.

Bronchitis is perhaps the most frequent accompaniment of infections of the nose and throat in small children during the winter months. Though in its severer forms a very distressing and disabling affection it is not usually dangerous. Attention to it is important, however, for at least two reasons; first, because recurring attacks of acute bronchitis accompanying every trifling infection of the nose or throat indicate a general lack of resistance in the child, such as occurs, for instance, in rickets; secondly, because chronic bronchitis may result in permanent damage to the bronchial tubes, with the production of a condition known as bronchiectasis. In this condition pus accumulates in unhealthy portions of the bronchial tubes, and gives rise to chronic ill-health and invalidism.

PNEUMONIA.

Broncho-pneumonia is the result of an infection of the bronchi, bronchitis, spreading to the tissues of the lungs. It is a common and very deadly infection in infancy and childhood. The course of the disease differs little from that in the adult, and will not therefore be again described here. Skilled nursing and medical attention are always needed.

Lobar pneumonia is an entirely different disease, and does not usually follow infection in other parts of the respiratory tract. In its early stages the disease may be difficult to diagnose in the child, as it is sometimes ushered in with symptoms closely resembling those of meningitis or of some acute abdominal disease, such as appendicitis. For a description of lobar pneumonia see the section on diseases of the respiratory system.

CROUP.

The word 'croup' is not now commonly used by medical men, but to the layman it still connotes a well-defined respiratory symptom. This symptom consists of a difficulty of breathing accompanied by a crowing or whistling noise, and is produced by some obstruction in the larynx

to the passage of air. The noise produced is known as 'stridor.' The word 'croup' was used in medical parlance to describe any disease giving rise to stridor, before the true nature of such diseases was understood. It is now known that at least three diseases were comprised in the term 'croup.' One of these was laryngeal diphtheria. The other two have little in common in reality, but will be discussed together here as they are both frequently spoken of as croup.

The first, laryngismus stridulus, is an affection of infants and children under three years of age. It consists of a spasm of the larynx, and occurs in association with rickets. It is frequently accompanied by spasms of the hands and feet, as well as of the larynx, and sometimes by generalized convulsions. The spasm may endanger life, and should always have medical attention. The measures for its prevention are those for the prevention of rickets.

The second condition, widely different from the foregoing, but frequently known as croup, is laryngitis stridulosa. In this condition a child, between the ages of three and ten years as a rule, will wake in the middle of the night and after a hard, barking cough, will experience great difficulty in drawing in breath, the act being accompanied by stridor. During the attack, which may last as long as two hours, the child is in great terror and distress, and feels as though he were suffocating. The attack may be relieved by the use of a steam kettle, by hot poultices or fomentations to the neck, or by a hot bath. An emetic will sometimes produce a relief of the spasm. The attack is very alarming in appearance, but harm very seldom results. The subject of these attacks is usually a nervous, 'highly strung' child, and the excitement of a party, or slight indigestion, or exposure to cold is often a predisposing factor. Some of these children develop asthma in later life.

While on the subject of stridor occurring in children it would be well to remember the possibility of an inhaled or, as the child if old enough will call it, 'swallowed' foreign body. Small toys and coins are frequently slipped into the mouth during play, and may go down 'the wrong way,' with disastrous results. Instant medical aid, even in the absence of acute symptoms, is imperative.

Diseases of the Digestive System

The diseases peculiar to the digestive system of the child serve well to illustrate two points in medical diagnosis, which the layman often fails to appreciate. The first point is the difference between functional and organic disease. As has been pointed out in the section on feeding the normal child, illness may arise in a child with a perfectly normal

intestine, by overtaxing its capabilities. Thus diarrhoea results from giving too much sugar to an infant. The normal function of the intestine is upset, but the intestine itself is not the site of disease. The organs are sound, but have been temporarily thrown out of normal working order. The same symptom, diarrhoea, may, on the other hand, result from an infection of the bowel by a harmful germ. An enteritis or dysentery results, in which case the intestine is the site of an organic disease.

The second distinction which should be understood is that made between a disease and its symptoms. Diarrhoea, vomiting, constipation, are not of themselves diseases, but may be symptoms of underlying disease. To treat diarrhoea and cause it to cease is a simple matter, but clearly a useless procedure if it is to recur as soon as the treatment is finished, owing perhaps to a faulty diet.

As, however, disease of all kinds makes itself known to the doctor largely, and to the layman entirely, by its symptoms, some discussion of the commoner symptoms occurring in connection with disease of the digestive tract in children may not be out of place.

VOMITING.

Vomiting is extremely common in infancy, and is accomplished with little or no effort or distress. It may be due to unsuitable food or to overfeeding with entirely suitable food. Owing to the facility with which it is accomplished it readily becomes a habit. Vomiting may result in under-nourishment, and herein lies its danger. The likelihood of this occurring can only be judged by the frequency and size of the vomits, and whether it is in fact occurring by a study of the child's weight-chart. Persistent vomiting, accompanied by failure to gain weight, should always be referred to a doctor, though a preliminary review of the nature and quantity of the food will often give a clue to the cause.

Projectile vomiting, in which the food is forcefully shot out of the mouth, sometimes to a considerable distance, is a common symptom of a happily rather rare condition known as pyloric stenosis. This is a condition in which the outlet of the stomach, the pylorus, is partially closed from birth. The symptoms do not usually appear until the child is about ten days old. Projectile and bulky vomiting then appears and the child begins to waste. The treatment is usually by operation, and is remarkably successful if undertaken early. Those cases, however, in which various foods have been tried, sometimes for a week or more before a doctor has been consulted, are often in so ill-nourished a state that the necessary operation is attended with great risk.

Apart from errors of diet or disease of the digestive organs vomiting

may be a symptom of disease in far-removed parts of the body, such as the ear, the kidney, or the brain. Almost any illness which causes a rise in temperature, such as measles, or scarlet fever, may be accompanied by vomiting of the child's normal food. It is for this reason that a light diet is prescribed during a bout of fever. It will be clear from what has been said, without further elaboration, that vomiting is not itself a disease, and is a symptom that may be evoked by trivial and easily corrected causes. If such a cause cannot immediately be found the wise course is to invoke medical aid.

CONSTIPATION.

Constipation consists in the passage of hard and sometimes infrequent motions. The consistency of the motions and the frequency with which they are passed depend upon the nature of the diet, especially relevant being its unabsorbable residue, and the state and habit of the bowel. As far as the bowel is concerned the new-born baby has no habit, but proper habits can quickly be established by training. To this end the infant should, from the first, be held out at regular intervals over a chamber-pot. The habit thus acquired must be maintained in later childhood; the importance of this is frequently not realized by parents of children of school age, who are, in this respect, too soon left to their own devices.

In the infant vomiting, if of any magnitude, is frequently accompanied by constipation. This is simply due to the insufficiency of food residue being passed through the stomach to the intestine. It ceases when the cause of the vomiting has been treated. In such circumstances it is clear that purgatives or laxatives are not needed. It cannot be too emphatically stated that the same thing is true of the vast majority of cases of constipation. Constipation is a symptom, either of faulty food or of faulty habit. Purgative medicines are only useful to re-establish a habit; they must be looked upon as a temporary expedient, never as a life-long habit; the weekly 'cleansing of the system' advocated in many advertisements is as far removed from true health as was the habit, attributed to the Romans of the decadence, of vomiting after excessive feasting.

DIARRHOEA.

Diarrhoea, or the passage of frequent fluid motions, is in all cases due to an increased irritability of the bowel. Normally the contents of the upper part of the intestinal tract, known as the small bowel, are quite fluid. As this fluid matter passes slowly through the lower or large bowel much of the water is reabsorbed, and a motion of normal con-

sistency results. If, for any reason, the bowel is irritated, it passes its contents along more rapidly, and less water is reabsorbed. Such irritation may be due to faulty food, to the swallowing of a poisonous substance, or to infection of the bowel itself. The fault in food may be due to excess of sugar or fat, or to the presence of an irritating ingredient. If due to infection, the causative germ may be comparatively harmless, and give rise to a transitory upset, or may, like the typhoid bacillus, give rise to a prolonged and dangerous illness. In young infants, however, diarrhoea should always be regarded as a potentially dangerous symptom. The treatment of diarrhoea consists, in principle, in removing the irritating substance and resting the bowel. The bowel is, of course, doing its best to achieve the first of these two ends, but it may in certain circumstances be assisted by the giving of a single dose of castor oil. The bowel is best rested by allowing no food to pass through it. The child is given nothing but water for a period of from twelve to twenty-four hours. Owing to the increased loss of water by the bowel during the diarrhoea, the patient is almost always in need of water, and this must be liberally supplied. After this period of rest for the bowel, the giving of food must be restarted with caution, only those articles least liable to irritate the bowel by their residue being included.

Before leaving the subject of diarrhoea it should be mentioned that this symptom may occur in nervous children from purely emotional causes. The treatment in this case is that of the nervous, highly-strung temperament.

Diarrhoea, like vomiting (see above), only less frequently, may be symptomatic of inflammation far removed from the bowel itself.

The bowel, when acutely inflamed, is, like other parts of the body, engorged with blood, and it is not uncommon for one of the engorged blood-vessels to break, with the result that blood appears in the motions. This is not in itself dangerous, but is an indication that the bowel is greatly inflamed. The passage of mucus, or slime, with the motion is due o an increased secretion by the mucous glands which line the intestinal tract, and is an expression of their irritation.

INTUSSUSCEPTION.

Intussusception is the name given to a condition occurring usually in perfectly healthy well-nourished children in the first two or three years of life, in which the bowel becomes folded in on itself, assuming the same position as a sleeve in which one has taken a 'tuck' to shorten it. The outer part of this 'tuck' then treats the inner part as it would any other substance inside it: it passes it on, thereby deepening the 'tuck.' The end-result of this process is that the bowel becomes obstructed, and an operation has to be performed for the relief of the condition.

Intussusception is accompanied by spasms of agonizing colic; each spasm lasts but a few seconds, during which the child screams and doubles up its legs. After the spasm is passed the child usually lies quiet and exhausted, sweating slightly, only to be doubled up by a fresh spasm in a space of half to one minute. Owing to the obstruction of the bowel little or no motions are passed, but blood and mucus is the usual result of much straining. Instant operation is necessary if life is to be saved.

PROLAPSE.

Prolapse or 'coming-down' of the bowel usually occurs only in weak and undernourished children. The immediate treatment consists in returning the prolapsed portion of bowel; this is best achieved by firm pressure with an oil-soaked rag. If any difficulty is experienced a doctor should be called in without delay. Preventive treatment should aim at building up the child's general health, and at avoiding straining during evacuation of the bowel; this last object is achieved not only by the use of mild laxatives such as petrol-agar or paraffin, but also by preventing the child from assuming the usual 'squatting' position during defecation. In severe cases it may be temporarily necessary to make the child open the bowels while recumbent.

WORMS.

The common type of worm infesting children in this country is the threadworm. These parasites resemble short pieces of white thread about a quarter of an inch long, and as they are but loosely attached to the bowel-wall from which they draw their sustenance, they are passed in great numbers in the stools. They can be readily detached and removed from the body by washing out the bowel with salt and water (a dessert-spoonful to the pint). A sufficient bulk of saline should be used to irrigate the whole large bowel; that is, about a pint and a half for a child two years old, and two pints for a child of six years. The saline is warmed and run in slowly by a tube and funnel. After the bowel is emptied the anus or outlet of the bowel must be covered with a dilute mercury ointment to prevent the escape of worms or eggs. Only by this means can reinfection of the child be prevented. The ointment must be applied two or three times a day, and at night on going to bed; the washing-out of the bowel is continued daily until no worms have been seen for three or four successive days.

Round-worms resemble in appearance the ordinary garden worm. Their elimination involves the use of drugs which should be administered under medical advice. The same is true of the tapeworm.

Diseases of the Urinary Tract

The urine is excreted by the kidneys and passes from these organs by tubes to the bladder, where it is stored until passed.

The passing of urine comes under the control of the will at the age of about a year or eighteen months. Delay in acquiring this control of micturition may be part of a general developmental delay in a child, or may be symptomatic of mental retardation in a physically normal child. Temporary loss of control is common in early years during any severe illness.

Nocturnal enuresis, or bed-wetting, is a very common and distressing complaint. It may be due to an infection of some part of the urinary tract (pyelitis or cystitis), to a stone in the bladder, or to local irritation due to a tight foreskin, worms, constipation, etc. In all cases such causes should be looked for and corrected. There remains a number of cases in which bed-wetting occurs which can be assigned to no such cause. These can be divided into cases occurring in highly-strung, emotional children, where the nervous control of the bladder is at fault, and cases occurring in dull, stolid children, where training is at fault, and laziness the cause. The former is by far the commoner type. The success of treatment depends almost entirely on tactful and intelligent handling by the adult in charge of the child. From the outset it must be realized that, to the sensitive child, the wet bed is as much a source of distress as it is to the parent. To add fear of punishment or even reproach to this distress is not only unkind, but quite useless. Furthermore, it must be remembered that bed-wetting in older children is often accompanied by an acute sense of shame; this must be dissipated. The best way to handle a case is for one understanding grown-up to discuss the situation sensibly with the child; nobody else in the household should evince any interest in the case. The child is then put on a perfectly regular regime; the last drink is given not less than one and a half hours before bedtime, and the child goes to bed at exactly the same time every day. This hour and a half is spent quietly; no parties. At some time during the evening, about ten or eleven o'clock, the child is wakened, and made to empty the bladder. This time must be fixed so that the child is not already wet when roused. A weekly score-card is kept, and during the first week the child is encouraged to try to have two dry nights. If this is achieved, and with proper 'suggestion' it usually is, the child must be praised and encouraged to do even better next week. In this way most cases can be cured. Medicines play but a small part in the treatment, but belladonna may have a sedative action on a too easily 'fired off' bladder, and a strongly acid urine may be made alkaline with advantage. In all cases a doctor should first be

asked to examine the urine so as to make sure that no organic disease is present.

Infections of the urinary tract are not confined to the period of childhood, and differ little in their symptoms from those of adults. As with all infective disease in the child the general symptoms such as fever, vomiting, diarrhoea, convulsions, may be severe and mask the local nature of the illness.

It is so frequent a complaint among mothers that their infant's urine is 'thick' in appearance, or smells strongly of ammonia, that a word on the subject of normal urine may not be out of place. Urine when passed is normally clear, almost colourless, or of a very variable depth of yellow. On standing in the air for even a short time it becomes cool and undergoes decomposition.

This decomposition is more rapid if the urine is passed into a napkin which, even after the most careful rinsing, usually contains traces of soap, and therefore of soda. As a result of this decomposition ammonia is set free and gives rise to its characteristic smell. The urine also becomes alkaline, which results in its becoming clouded with solid matter (phosphates). If, on the other hand, it is strongly acid when passed cooling may also result in clouding and the formation of a fine red deposit. These happenings are normal; for purposes of diagnosis, therefore, the urine should always be examined immediately after being passed. If it is then 'thick' or discoloured, medical advice should be sought.

In infants a further result of the freeing of ammonia from the urine may be the production of a napkin rash. This may be prevented by using a strong solution of boracic crystals for the final rinsing of the napkin.

Circumcision

The question of whether or not the operation of circumcision, or removal of the foreskin or prepuce, should be performed is one that often worries the conscientious parent. As informed opinion is divided on this point a simple explanation of the anatomy of this part of the male genital equipment and of the points at issue may not here be out of place. The prepuce consists of a cuff of skin which covers the glans of the penis. The glans itself has a delicate and more sensitive covering, and the object of the prepuce appears to be to protect the glans. In certain babies the opening of the prepuce is so small as to obstruct the flow of urine. This condition of smallness of the preputial outlet is known as phimosis. Even if the outlet is sufficiently large to allow free passage of urine it may be too small to permit of the prepuce being drawn back from over the glans. If this is so, material may collect under the prepuce, and in course of time set up an inflammatory

process. This inflammation may result in the prepuce adhering to the glans, or such adhesions may be present from birth. Alternatively the prepuce may be quite loose, but too long, and project beyond the glans as a skinny tube; it is then apt to contain stagnant urine, which, when decomposed, is a source of irritation. So we have three possible, and common, abnormalities: (1) the tight prepuce or phimosis; (2) the adherent prepuce; and (3) the long prepuce.

With regard to the first it may be said that though most newly-born infants appear to have a rather small opening to the prepuce, this frequently rights itself rapidly without any treatment. If, however, there is obstruction to the flow of urine, circumcision should be performed. The second condition of adherent prepuce can easily be dealt with by the doctor, who frees the adhesions with a probe. The long and water-logged prepuce is best dealt with by circumcision.

Diseases of the Nervous System

The fact that the child, considered as a whole, is a highly unstable organism has been emphasized on more than one occasion in these pages. This instability finds no better illustration than that afforded by the developing nervous system, which, in its response to disease, may be likened to a charge of high explosive which a small spark coming from a distance may ignite, and the response thus be out of all proportion to the original cause.

CONVULSIONS.

Convulsions may be the accompaniment of almost any acute illness in infancy. When caused by such mild conditions as teething or constipation, they indicate an instability of the nervous system which is outside the normal, and requires treatment. Even at the onset of more severe illness, such as scarlet fever, measles, or urinary infection, it cannot be said that convulsions occur in the perfectly normal child, but their import is in such cases less serious. In diseases involving the brain itself, such as meningitis, encephalitis, or infantile paralysis, convulsions almost invariably occur. It will be seen, therefore, that infantile convulsions are not in themselves a disease, but may be one symptom of a variety of conditions more or less grave. The more trivial the immediate cause, the more unstable must be the brain acted upon. During a convulsion the child is seen to turn pale, and the eyes to roll or become fixed in a vacant stare, while consciousness is lost in a greater or less degree. The breath is sometimes held or becomes jerky and irregular, while the lips go purple or even blue. Convulsive movements may be confined to the hands or to the head and neck, or they may become more generalized until the whole body is involved. Chewing

movements of the jaw are common and result in the formation of froth around the lips. After the convulsion the child usually lies exhausted and sleeps.

The treatment of the convulsion itself is important, and consists in placing the child in a warm bath, the heat of the water having been previously tested by immersing the elbow. This is very important, as the unconscious child is unable to protest, and may be badly scalded if the water is too hot. While in the bath the head must be firmly held to prevent any possibility of the water entering the nose or mouth. Sponges of cold water may be applied to the head. If the convulsion has not ceased after five minutes' immersion in the bath the child should be removed, rapidly dried, and wrapped in warm blankets. At the onset a doctor should in all cases be summoned, as drugs such as chloral and bromide may have to be given. At the end of the convulsion the child should be allowed to sleep; the popular practice of attempting to rouse the patient is altogether wrong.

TETANY.

Tetany is a rare and special form of convulsion occurring sometimes in connection with rickets. It is characterized by a curious cramped position of the hands, the fingers being held straight, and the thumbs turned in across the palms, and of the feet, which are arched towards the soles in spasm, while the corners of the mouth are drawn up by twitchings of the face. Immediate treatment can only be carried out under medical supervision, but the ultimate cure consists in treating the underlying rickets or other cause.

TIC.

Habit spasm or tic consists in the constant and meaningless repetition of a voluntary movement. It usually occurs in a nervous or debilitated child. Examples of such tics are afforded by blinking, head-tossing, and clearing the throat. All these movements have their origin in a voluntary movement made with a purpose, blinking to relieve eye-strain, moving the head to ease a tight collar or toss a stray lock of hair away from the eyes. While they have a purpose they cannot be called tics; but in certain cases they persist long after the need to perform them has ceased. They have become habits. Though often very annoying to those who have to witness them, and disfiguring to the patient if they take the form of grimacing or blinking, they are carried out unwittingly. They can, however, be brought under voluntary control, and treatment should aim at this. Usually the tic gets worse when the patient is embarrassed or nervous. Sympathetic handling of such cases is therefore needed, and much encouragement; scolding by grown-ups, or jeering and imitation by other members of the family or

schoolfellows, both have a very adverse effect. Attention to the general health is of primary importance, and a holiday in new and interesting surroundings will often hasten cure. It must be remembered that such tics are often imitated by other children, who thereby acquire the tic themselves.

CHOREA.

Chorea, or St. Vitus's dance, can be distinguished from habit spasm by the fact that in the latter the same movement or group of movements is repeated, while in chorea, even when only part of the body or one limb is affected, the spontaneous movements are never twice the same. In chorea the movements differ entirely in character from those of habit spasm in being jerky, obviously purposeless, and quite involuntary. They are due to a disease of the brain caused by the germ of acute rheumatism. In severe cases the movements can be very exhausting, but the chief danger of chorea lies in associated rheumatism, with its damaging effect on the heart. Chorea, unattended by heart disease, is not of itself a dangerous disease. The temporary mental changes occurring in chorea are important. They consist chiefly of emotional instability, so that the child laughs and cries with unusual ease.

Treatment consists in absolute rest and avoidance of anything which may give rise to a strong emotional reaction, whether painful or pleasurable. These cases should always be under the care of a doctor.

ANAEMIA

Anaemia is the name given to a condition in which there is deficiency of haemoglobin in the blood. Haemoglobin is the red substance which is responsible for conveying oxygen from the lungs to the rest of the body. The deficiency may be simply due to lack of haemoglobin, or may be due to a lack of the blood-cells which carry the haemoglobin, the red blood-cells. Haemoglobin contains iron, and the commonest type of anaemia arising in infancy is due to a lack of iron in the diet. This nutritional anaemia is especially common in artificially-fed infants. Foods containing iron are green vegetables, especially spinach, and egg-yolk.

Anaemia may also arise as the result of illness. This may be an acute illness, such as rheumatism or diphtheria, or a chronic disease, such as tuberculosis. Other chronic infections of a less definite character, such as infected tonsils or teeth, may in time cause marked anaemia. The treatment in such cases is that of the causative condition in the first place, but recovery can be hastened by a plentiful diet of fresh food, open air, and iron-containing medicines.

XXI—AILMENTS OF WOMEN

Most gynaecological troubles can be placed under one of three headings: (*a*) injury; (*b*) infection; (*c*) tumours.

Injuries

These are usually caused by child-birth. The vagina may be badly torn, as may be the supports of the womb and bladder. The result is a dropping of either the womb or the bladder, or both. The woman complains of weight and discomfort between the thighs, and may have considerable difficulty with her bladder. She may find it difficult to hold her water, and may have to pass it very frequently; or she may not be able to pass it properly when she desires. The symptoms are much worse by day, usually causing very little trouble at night. The condition is easily corrected by a plastic operation. It is the height of folly for a woman to rely on a pessary in these cases, because ultimately it will prove unsatisfactory—and then, when she is older, and the condition has become worse, an operation may be less successful than it would have been when she was strong and healthy.

Infection

Infection of the genital tract may arise either from above or below. Apart from gonorrhoea, infection occurs more frequently as the result of child-birth than from all the other causes put together. Tuberculosis, and infection spreading from the appendix or some other part of the bowel, account for a very small percentage of cases. All infections may affect the Fallopian tubes, and cause a localized peritonitis and abscess-formation in the pelvis. The symptoms are much the same however the infection is caused, and include severe pain in the lower part of the abdomen, irregular bleeding and disturbance of the monthly periods, and frequently bladder symptoms. As the infection becomes chronic the pain becomes of a dragging character in the lower part of the back, and is frequently most troublesome when the patient retires for the night. Rest in bed and general hygiene are indicated during the acute stages, whilst later the pain may be relieved by hot douches. It is essential to avoid constipation. The infection is liable to light up at infrequent intervals. Seeing that the woman is inevitably rendered sterile, it is advisable, if the pain persists or is severe, to remove the womb and the Fallopian tubes, and so leave her with a 'clean' pelvis.

VENEREAL DISEASES.

There are two important venereal diseases: gonorrhoea and syphilis. They are most commonly acquired through irregular sexual intercourse; but may sometimes be caught by the careless use of public lavatories and lavatory towels.

Gonorrhoea. This disease commonly affects the urethra or water-passage, and the neck of the womb. In young girls it affects the vagina, rectum, and urethra. The first symptom noticed is a scalding pain while passing water. Later a heavy yellowish-green discharge from the vagina becomes apparent. The individual should seek expert medical advice immediately such symptoms occur, particularly if the risk of infection has been taken. There are now a large number of centres in most cities where expert treatment may be obtained free of cost and with absolute secrecy. The urinary symptoms are easily cured if treatment is commenced early. The organisms of germs in the neck of the womb prove very difficult to kill, although the discharge may be considerably lessened. It is of the utmost importance for the woman to realize that, although she may not be suffering any serious physical discomfort, she is capable of infecting her partner during sexual congress until she is cured. Further, the infection may travel upwards to the Fallopian tubes, and cause a localized peritonitis and a great deal of suffering and ill-health. Moreover, the infection may get into the blood-stream, and cause swelling and pain in the joints. It is very difficult to cure gonorrhoea. Some people go so far as to say it can never be cured. By causing inflammation of the Fallopian tubes, gonorrhoea is a common cause of sterility. Besides infecting the partner during sexual congress, the vaginal discharge may in young girls cause infection of the vulva and blindness if it gets in the eyes. During child-birth the eyes of the infant may become contaminated, and this was at one time the commonest cause of blindness. The sufferer should therefore take the utmost precaution to keep separate the towels she uses, and be scrupulously careful when using the lavatory. The best advice may be summarized as follows: Avoid irregular sexual intercourse; be careful when using public lavatories; and seek expert advice as soon as you believe you may have become infected. Perhaps the greatest tragedy associated with the disease is the lighting up of an old infection after many years, causing a man who considers himself cured to infect his own wife.

Syphilis. Whereas gonorrhoea is mainly a local disease, and spreads by direct extension, syphilis is a generalized disease which affects every tissue of the body. The first stage of the disease is a sore or chancre where inoculation occurs. In the female it may be situated on some part of the vulva or directly on the cervix. The next stage of the disease is heralded by a rash which may simulate nearly any skin disease. The

third stage affects almost any tissue of the body, and causes such diverse lesions as damage to the blood-vessels and general paralysis of the insane. The disease is acquired in the same way as gonorrhoea, and is equally difficult to cure. The trouble is that a man in the third stage of syphilis may infect his wife without causing any symptoms. Nevertheless, the disease of which she is unaware may cause miscarriage after miscarriage, and finally diseased babies. An infant may be born with syphilis—and suffer many different and severe troubles throughout its diseased life. Fortunately, it is possible to test whether a person has the disease by an examination of the blood. If a woman has one or more miscarriages, not only her own blood, but also that of her husband should be tested. If either of them is diseased, both must be actively treated for syphilis before a further pregnancy is considered. Syphilis and Bright's disease are the commonest known causes of repeated miscarriages.

LEUCORRHOEA OR THE WHITES.

The vagina is normally kept moist, but there is no noticeable discharge. Sometimes the discharge is excessive, and is usually most noticeable just before and just after the periods. It may be white, whitish yellow, or yellow, in colour; and varies from a thin to a thick sticky fluid. It may be very abundant, and cause offence as well as irritation.

The whites must be recognized as an infection which most often affects the neck of the womb. The discharge may come from the womb, the Fallopian tubes, or, less commonly, from the vagina. In quite a high percentage of cases the whites commence soon after the onset of menstruation, and then must be regarded as a 'cold,' in all respects similar to a nasal discharge. It is thus important for parents to see that girls are provided with suitable warm garments, and are not subjected to undesirable cold draughts. Leucorrhoea which commences later in life is usually due either to injury to the neck of the womb and infection, associated with child-birth, or to gonorrhoea. The treatment of the condition naturally depends on its cause, but simple cauterization of the neck of the womb leads to improvement in very many cases.

TUMOURS

The majority of tumours of the womb are harmless, except in so far as they cause excessive bleeding. Fibroid tumours may be removed from the womb. Unfortunately cancer is not so easily dealt with.

CANCER.

It would seem that a greater number of people than ever are dying from cancer. This may in part be due to the fact that the expectation

of life has increased, with a consequent increase in the number of people who reach the 'cancer age,' and in part to the fact that doctors are more careful than formerly in the certification of death. By far the greatest number of women afflicted with cancer suffer from the disease either in the breast or in the womb. It is somewhat surprising that women who have never had children are as likely to get cancer of the breast as those who have suckled many children. Cancer of the neck of the womb, however, occurs much more commonly in the mothers of children.

Although no age is exempt, cancer occurs most commonly after the age of thirty-five years. It is, in its early stages, invariably painless. If cancer is diagnosed sufficiently early it may be cured by surgery. There are many people who urge that individuals should be examined every year in order that this disease may be discovered in its early stages. This view has much to recommend it. Unfortunately cancer in its early and often easily curable stages is not easy to diagnose, and frequent medical examinations are apt to induce a mental state called 'cancerophobia.' Fear of cancer can be a terrible affliction, and if it became widespread would be too heavy a price to pay for the relatively few lives which this mass physical examination would save.

Cancer of the Breast. Any woman who notices a lump in the breast which is quite painless should obtain an expert view as to its nature. The great thing is to obtain an opinion as soon after it is discovered as possible.

Cancer of the Neck of the Womb. If a woman suffers from irregular bleedings, and a sudden increase in the 'whites' at or shortly before the menopause, she should submit to a thorough medical examination. If there is any doubt, a small piece of the tissue can be removed, and examined under the microscope. In nine cases out of ten another cause for the bleeding will be discovered; but in the odd case an early examination may lead to the cure of an otherwise fatal disease.

The two methods of treating cancer with any hope of success are: (*a*) surgery, and (*b*) radium and the X-rays. In recent years some promising results have been obtained in the treatment of cancer by radium; but we have no radium institute in this country comparable with those in Paris, Stockholm, and other continental cities; and we certainly have not obtained the good results that they claim. There can be little doubt that if the disease is discovered sufficiently early its removal by the knife is the safest course to adopt. The cause of cancer is unknown, and it does not follow, even if its cause does become known, that its prevention and treatment will be more readily effected. The important thing is to seek expert medical attention if a painless lump is discovered in the breast, or if irregular bleeding or an increase in the 'whites' occurs after the age of thirty-five years.

THE MENOPAUSE OR CHANGE OF LIFE

It has already been said that ovulation is the fundamental fact of the sexual life of the woman. Shortly after fifty years of age this function, together with menstruation, ceases. In the vast majority of cases child-bearing becomes no longer possible, although cases are on record where girls have become pregnant before their periods have commenced, and women have given birth to children long after the change of life. The menopause is often associated with a great deal of discomfort and considerable physical and psychological changes.

The well-being of the body depends largely on the harmonious working together of all the endocrine glands. The sudden cessation of ovulation tends to throw the other glands out of gear, and most of the symptoms associated with the 'change of life' are due to irregular functioning of all the endocrine glands. The commonest symptoms are 'flushings of hot and cold,' which may be extremely distressing. Other symptoms are excessive salivation, pains and swellings in the joints, skin rashes, buzzings in the ears, and sometimes disturbances of vision. The changes that occur in the character of the individual are often very subtle, and some people become difficult and unreliable; indeed, the mental changes may proceed to insanity. The more 'nervy' and highly strung the woman the more is she likely to be disturbed. There is a distinct tendency to put on weight at this time. Menstruation may cease abruptly, or may gradually disappear after a period of irregularity. The symptoms commonly persist for three to six months; but some women take five years to 'get over' the change of life. Attention to hygiene and diet, and sympathetic advice and understanding, help in all cases. It is essential that the woman should understand what is happening, and that she should try to fight her own battles. Occasionally, medical treatment is needed, especially if irregular bleeding occurs.

XXII—ELECTRICITY IN MEDICINE

THERE is a certain glamour about the word 'electricity,' and there is enough mystery and fearfulness in the blue sparks and the 'shocks' of an electrical machine to cast a spell over the most sophisticated and most stolid among us. We all feel that there is some eerie and all-powerful medium at work, capable of performing miracles, and of producing cures when all other remedies have failed.

Nor are we so very far misguided in our beliefs. Six hundred years before the birth of Christ, the Greeks were making discoveries about the attractive powers of amber when it was rubbed with a piece of fur. Two thousand two hundred years later a certain Dr. Gilbert found that many other substances, including resin, amber, glass, and sulphur, possessed the same properties, but that in addition they had in certain circumstances the power of repelling the various light articles placed near them. But in all these experiments the nature of the energy remained undiscovered, and in the seventeenth century there surrounded the name of 'electrics' as much superstition as that associated with the nostrums and placebos and incantations of the quacks and apothecaries. To a great extent that fear of the unknown has persisted to this day, so that electricity is still to most of us a force which we know by instinct and by experience to be of almost supernatural influence in our lives.

ELECTRICAL APPARATUS USED IN MEDICINE

The accumulation of electrical power began with very simple condensers, called 'Leyden jars.' These were devices which could be charged with a certain amount of electricity under pressure, and they were able to give out their retained power when necessary. They were said to possess so much potential, and the work they provided was known as electro-motive force.

Once a start had been made with the investigation of movable electricity, endeavours were made to produce a flow of electricity which would be capable of generation at any time and for a prolonged period. Thus the cell was produced. This consisted of two different kinds of metal (e.g. copper and zinc) immersed in a weak acid. When the copper and zinc were joined by a conducting wire, the current flowed from the copper to the zinc, and it continued until the metals or acid were so weakened that they were incapable of further interaction. Many

types of cell are in use to-day, providing currents of small power, but capable of ringing electric bells, and of supplying electricity for physiological experiments.

Now it so happened that many experiments with magnetism were made in the early part of the nineteenth century by a number of scientists, including Michael Faraday. It was found that there was a close relationship between electricity and magnetism, and that indeed an electrical current could be produced by the dynamo, a generator depending for its action upon electro-magnetism mechanically produced. This has led to great advances, especially in medical science. Probably the greatest development of electro-magnetism has been the production of what is known as the 'induced current.' If an electrical current is passed through a coil of wire, and a second coil of wire is moved backwards and forwards in the vicinity, an electrical current will be set up in the second coil. A further development of this power is manifested in the fact that if the current passing through the first coil is frequently stopped and started again, it induces a current in the secondary coil. These phenomena have led to the use of the induction coil, a simple apparatus made by winding round a small cylinder of iron a few turns of thick copper wire, perfectly insulated by a non-conducting substance such as rubber composition or other material known to be a non-conductor of electricity. The secondary coil is made by using the finest copper wire, and by winding numerous turns of it in the form of a sleeve or pipe surrounding the primary coil.

Electricity and the Human Body

Nobody has yet solved the problem of the power that is the basis of our life's activities. The heart beats steadily on, night and day; the muscles of our legs normally transport us from place to place, and the internal working of the various other organs of the body proceeds according to Nature's plan; but all the physiological research has not succeeded in identifying the vital force. There is a great similarity between the effect of electricity and the power produced or liberated by the nervous system. Indeed, we can liken the brain to a great central generating station, providing the current for a system of telegraphy. Millions of tiny cells are found in the brain and the spinal cord, and each of these gives off a long thread-like fibre, which either conveys messages from the cell to the muscle or other tissue, or receives messages sent from one or more of the millions of nerve-endings closely packed together on the surface of the skin and on the muscles and special organs. In addition to this, the cells and groups of cells are joined to each other by shorter 'side-wires,' the nervous system being in fact a

huge co-ordinated organization, maintaining effective means of communication between the units of the body.

When we wish, say, to lift a cup of tea to our mouth, ideas prompt the specific nerve-fibres, which run in bundles, and finally in nerves, to convey the message down their trunks, and this is appropriately interpreted at the muscles themselves, so that contraction occurs, and the requisite actions of lifting the cup are performed. Again, we are provided with sensations of pain, of heat, of cold, of touch, and of weight and position. These are messages sent to the brain from the receptive stations placed on the ends of certain nerve-fibres, and they act as protective signals to the individual, saving him from injury, protecting him from harmful influences, and advising him of the presence of abnormal conditions. Such messages continue until the wrong has been put right.

If electricity is not the form of energy constituting the vital force, the latter is something very much akin to it. This is proved by the fact that application of very small currents of electricity to the skin causes a muscular response and also on occasion sensations imitative of those produced by normal influences. If a muscle of a frog, together with its nerve, is removed from the frog immediately after it has been killed, and if a small current of electricity is passed through the nerve from above downwards, the muscle will contract in exactly the same manner as it would do were it still in the living animal. This is but one example of the similarity between nerve force and electricity. The latter is becoming more and more involved in the explanations of the workings of the body. For instance, the heart sets up small currents as it beats, and these can be recorded on the modern *electrocardiograph*, an instrument of great sensitivity and of inestimable value in the diagnosis of heart abnormalities.

It is clear, therefore, that there is some unexplained common factor in existence between the nervous energy and electricity; though, so far, we have made only a very little progress in the elucidation of the mystery. But we have made full use of the knowledge we possess to devise instruments and apparatus which may be employed in testing the limbs or other regions for defects, which can be registered by these machines. A nerve which is damaged becomes degenerate, and complete or partial loss of power of the muscles of the region is the result. This degeneration may be accurately gauged by electrical instruments which indicate the degree of power left in the service cable of the muscular group; therefore it is possible to make some assessment of the state of the nerve, and of the capabilities of the muscle. These tests are of great value when a person is recovering from a stroke of paralysis or from the effects of injury.

Many other tests can be made by utilizing the powers of electricity,

and some of these are referred to later. Meanwhile we must now consider how the various forms of electricity are applied to the human being as remedies for disease or injury.

How Electricity is Employed in Disease

All kinds of apparatus have been used for the treatment of disease by electricity, ranging from the simple, primitive 'battery' to the complicated X-ray installation. Like everything else, electricity has had its vogues, and it is questionable if some of the present-day methods of treatment have not obeyed the dictates of fashion rather than those of science.

It must be remembered that many mistakes were made, and that many accidents, mostly of a mild nature, occurred while the various procedures were being evolved. Undoubtedly, many of the earlier forms of 'treatment' were frankly of an empirical nature. People persevered with and suffered from those primitive infernal machines because they had faith in them, and not because they enjoyed the experiences. Any one who has lightheartedly consented to risk a shock from a 'magnetic machine' worked by a wheel, and its two ominous brass handles, can testify that at best such therapy was more of a grim practical joke for a Christmas party than anything else. A new discovery always brings with it many imitations. Electricity was no exception to the rule. In the market-places, on the stage, and in the less reputable shops, there were exhibitions of apparatus and effects that must have struck terror into nervous old ladies with rheumatism, and weedy young men who sought to make proof of the statement that 'electricity is life.' The days of the magicians who pulled sparks out of the body are rapidly passing. Nevertheless there still appear notices in the newspapers vaunting the benefits of batteries, belts, and other appliances, most of which are of no more value than an old-fashioned charm.

The great danger of electricity lies in its simplicity; the number of accidents which occur owing to handling of live wires or rails, or to touching points at which electricity is passing at high tension, is sufficient proof of this. It may be said, however, that modern electrical apparatus used in medical treatment is so well devised that there is practically no risk either to the patient or to the operator. Assuming that a doctor or a qualified nurse or attendant fully conversant with the working of the apparatus is in charge, nothing should go wrong. But there is undoubtedly some risk in the application of electricity by inexpert hands. It should be a rule that no electrical treatment of any description should be carried out unless there is qualified supervision.

GALVANISM.

In the realm of medicine the direct current (D.C.) is known as the constant, or galvanic current. It may be drawn from the mains and reduced in quantity until there is just enough to cause a comfortable reaction in the patient. Otherwise it may be furnished by accumulators, cells, etc., so long as they set up a constant current flowing in one direction. The volume of current required is expressed in milliamperes, and every apparatus is fitted with an accurate indicator which shows the operator the exact amount of current passing through. A controlling key allows for alteration of the current as may be required. Apart from its use as a testing medium for degenerating and recovering nerves and muscles, galvanism, as this form of electricity is called, is extensively used for treatment of these states, since it acts as a stimulant. Properly applied, galvanism should not cause the slightest shock or discomfort. If the current is suddenly switched on, and just as suddenly switched off, there undoubtedly will be an uncomfortable 'jump' of the muscles, but with gradual induction and gentle reduction, the patient need not be aware that anything has happened. He may rest quietly on a couch, or sit up if need be, the part to be treated being freely exposed. The current is circulated by means of two insulated wires, known as rheophores, which connect the electricity between the positive and negative poles of the apparatus, each terminating in a small flat disk or square of metal covered with chamois leather, and known as the electrode. The electrode is the connecting link between the skin and the source of the current, wherefore we must make sure that the contact is good. With this in view it is customary to soak the electrode in a solution of weak salt and water, and to press it firmly against the skin. In galvanism we may use the electrodes in various ways. One is securely fixed by pads to the back, and since it is used merely to make the circuit continuous, it is called the indifferent electrode. The remaining electrode may be fixed or movable, according to our needs. If we wish to alleviate a painful area, we generally use the fixed method, but when muscles have to be stimulated, the movable roller method is used, the roller being passed frequently over the muscles. Alternative methods are the employment of clockwork and mercury current-breakers, which act by rhythmically stopping the current for a moment.

IONIZATION.

Ionization, a method of splitting up small particles of certain drugs into atoms charged with positive or negative electricity, and so conveying them to the tissues by penetration of the skin, was at one time considered to be of great chemical benefit in rheumatism, and it was thought that the iodine or chlorine so liberated destroyed the rheumatic elements.

This has proved to be wrong; all these theories having been abandoned in favour of the old idea that the cure is due to the increase of internal heat. And, for the present, we must content ourselves with the effect and not with the cause of the improvement which undoubtedly occurs when galvanism is applied to cases of severe neuralgia, neuritis, or other painful states, of warts, corns, chilblains, and birth-marks, of stiff muscles, and of adhesive tissues.

FARADISM.

If a direct current is passed through the primary coil of an induction set, and is frequently interrupted by a vibrating hammer, there is induced in the secondary coil another interrupted current known as the induced or faradic current. The latter is very useful for the relief of headache or neuralgia; for the development of muscle by stimulation of the appropriate nerve, provided the nerve is still alive; and for the maintenance of a group of muscles in good condition when, owing say to splinting or injury following accident, the limb is in an immobile condition. In most cases the movable electrode must be used, and the current must be carefully regulated. For chronic constipation, faradism is often helpful because it stimulates the lower abdominal muscles.

HIGH-FREQUENCY.

Treatment by high-frequency consists in the application of an electric current alternating at a very high rate—often a million or more oscillations per second. In this form, electricity is delivered to the surface of the skin in glass-bulb electrodes, which are free of air and through which the current passes when transformed by a special apparatus. A bright violet light, and a certain amount of sparking, is produced when the bulb is placed on the skin. It causes a pleasant warm sensation, and has a soothing effect. This type of treatment must not be confused with ultra-violet light therapy, which is fully discussed elsewhere in this work. High-frequency treatment relieves many painful states, and it may be used to hurry on the healing of ulcers and other broken skin conditions. No doubt the basic effect is one of increased heat; indeed, in nearly all forms of electrical treatment it is becoming clear that we have two main actions, viz., muscle-contraction and production of increased temperature, and possibly the latter depends upon the former. If the electrode of the high-frequency set is applied long enough to an area, it may cause a reddening similar to that which appears after a poultice has been on.

DIATHERMY.

Diathermy treatment is a form of high-frequency; the word itself indicates 'heat-penetration.' Owing to the great number of oscillations, a current of as much as two amperes may be passed through the body. The electrodes are of thin, flexible sheet metal, and are covered as

usual with lint which has been soaked in salt solution. In lumbago, and other rheumatic conditions, in pneumonia, in weak circulatory conditions, in sleeplessness, and indeed in all conditions in which suffused heat is of benefit, diathermy has proved outstanding in its efficiency. The currents, passing through the successive layers of tissue, seem to cause a loosening of the adhesions, an increase of the blood-supply, and a greater degree of vitality. In diathermy we may expect to find certain useful developments along restricted lines. Professional experience proves that diathermy is often efficacious when many other methods fail. There is one other interesting aspect of this form of electricity which deserves mention. In surgery the tissues are cut with a sharp steel knife, and as the small arteries are cut they have to be tied with ligatures, or crushed in order to stop the bleeding. Many surgeons have adopted the diathermy needle or knife, which is simply a minutely thin electrode, carrying a concentrated current on its edge. Just in front of the blade, as it is applied firmly to the skin or flesh, a powerful, destructive current passes like a line cut by a knife, and so the surgeon can use the diathermy current to make incisions, being greatly assisted by the fact that as the current literally burns the tissues it also seals up the ends of the arteries. In many serious operations such as those of removal of the breast or of the tongue the diathermy knife has proved of great advantage in preventing undue bleeding, and rapid healing has followed.

X-Rays in Diagnosis and Treatment

The history of X-rays is full of romance, excitement, and danger. There can be no doubt that the discovery by Professor Röntgen, at the end of last century, of the powerful cathode rays, which were produced by passing a high-tension current through a large vacuum tube, was the beginning of a distinct epoch in medical science. Nowadays the science has been simplified and the work of radiology made comparatively easy, but it must be remembered that the modern apparatus, which by the pressing of a switch will disclose the mysterious bones, kidneys, lungs, and all the other constituents of the region we indefinitely style as our 'inside,' has been evolved by the sacrifice of time, money, limb, and even life of those stout-hearted pioneers of early days. We need not enter into a discussion of the scientific construction or of the somewhat confusing principles which govern the production of these valuable rays. Suffice it to say that when the rays are passed through the body and are interrupted by a special fluorescent screen or photographic film, a picture of the shadows of the main structures is obtained. As far as bones are concerned, these stand out very clearly, and the slightest defect can be noted. The same applies to safety-

pins, coins, and other metal articles swallowed by children and others, to stones in the urinary tract or in the gall-bladder, and to certain massive collections of fluid found in pleurisy and in abdominal inflammation. Apart from these, however, it is possible to cast shadows of the organ by filling it with drugs such as barium and bismuth (used in the stomach and bowels), by using special solutions which show clearly the kidneys and bladder, gall-bladder, and even the arteries, and by making special arrangements to bring other organs into greater prominence, e.g. the heart and lungs. We can sum up the situation by saying that during the past twenty years there has been a steady advance in the methods of investigation of the body by the use of the X-rays, and that there is every probability that the progress will continue.

X-RAY TREATMENT.

From the treatment point of view the value of the X-rays has been conclusively proved; but X-ray treatment should always be controlled by experts, and there is already an army of specialists who have made themselves skilled in the technique of X-ray and radium therapy. Much of the success of X-ray treatment depends upon the full appreciation of the disease present, of the immediate, as well as the distant, involvements, having regard to both time and place, and of the reaction of the patient himself to the medium at work.

There are certain diseases which have been found almost specific in their response to X-rays. First and foremost we may consider cancer. Success has been attained in clearing up accessible cancer on the skin, the lips, the tongue, and the cervix of the womb. But despite the development of carefully devised forms of prolonged exposure periods, of restricted and intensified applications, of superficial or deep therapy, of mass-radiation, and of other types of treatment, there are still many barriers obstructing the solution of the problem of curing the deeply-seated, inoperable, or recurrent cancer.

There is one bright and shining light in X-ray therapy, however. Ringworm, a disease which affects the hairs and the little root-canals in which they grow, can be definitely eradicated by X-rays. This treatment is much in use in school clinics. Three weeks after proper exposures have been made, the hair begins to fall out, and by the end of the fourth week the scalp is as bald as a billiard-ball, Irate and anxious mothers and self-conscious scholars are appeased by the appearance of a delightful coiffure some two months later, this being luxurious, strong, and often curly, so all ends well. X-rays may also be used in septic conditions of the tonsils, in certain chronic skin diseases, such as eczema, and in the reduction of the swelling of the thyroid gland known as goitre. All these conditions are, in suitable patients, very much improved by appropriate doses.

Radium

We have referred to the similarity between the effects of radium and of X-rays. Radium is a rare substance, of extraordinary power. It is obtained by extraction from pitchblende, but the amount produced after refinement of thousands of tons of the latter is so minute that the demand is hopelessly in excess of the supply. From radium there emanate three types of ray—the alpha, beta, and gamma rays. As far as we know, the alpha rays are not of any use in the curing of disease. The beta rays influence the skin to a certain extent, and may be used for destroying warts, corns, and other excrescences. The gamma rays are few in number; but their defect of quantity is made up by a quality which is as powerful as the strongest X-rays, and, since their action is very similar, they may often be substituted for X-rays or used with them.

Radium must be controlled, otherwise the rays would be very dangerous. This control is exercised in various ways, the chief being the imprisonment of radium in a hollow platinum needle less than an inch long. Plaques may also be used, these consisting of square or round applicators containing a radium salt, and protected by silver, platinum, or lead. By this means the local effect of the rays is prevented, and the action is allowed to proceed at a deep level. Radium may also be used as 'radon tubes,' these being used as 'seeds' buried in the diseased tissues. The latest development of radium treatment is the 'bomb.' For various reasons the introduction of needles into the tissues became unpopular. In the bomb it is possible to enclose five or ten grains of radium, and in the United Kingdom one grain is at present being used. The advantages are that this form of surface application gives a uniform radiation. The disadvantages are that there are not enough bombs for the fight. The maximum number of patients that could be dealt with is about two hundred, assuming that a five-grain bomb were decided upon as a 'therapeutic unit' for this country.

As with X-rays, it is too early to say anything definite about radium. Much research is going on, and must go on for a long time yet. There is no question of the dramatic disappearance of cancer, no possibility of sudden and miraculous cures. Unfounded optimism has made the layman imagine that radium acts like a magic wand. But our bright hopes must be tempered with a great patience which may help to tide us over the long period that must elapse before we know exactly where we are so far as radium and X-rays are concerned.

XXIII—LIGHT RAYS IN MEDICINE

LIGHT, in some form or other, is essential to the well-being, indeed, to the very existence, of human and animal life. Research shows us that exposure to the sun's rays was a form of medical treatment in use during the earliest times of which any record is known; and there is evidence that even the cave-men of prehistoric times realized the value and importance of sunlight, since their habitations were so placed as to receive the maximum amount of the sun's radiance. It may be assumed that the sense of health and vigour which they recognized as attributable to the potency of light, no less than the warmth and comfort bestowed by the sun, gave birth to a feeling of gratitude—a desire to express thanksgiving; and thus, possibly, were sown the first seeds of religion. These prehistoric folk began to worship what they considered the fount and origin of their health and happiness—the sun.

Medical treatment by the sun's rays was, archaeology would suggest, practised seven thousand years ago by the inhabitants of Mesopotamia; for surviving wall-carvings show us that the ancient Assyrian arranged a sun-bath on the flat house-top or roof of his house. More than three thousand years ago, Akhnaton, Pharaoh of Egypt—'Son of the Sun,' as he delighted to call himself—founded a definite religion of sun-worship, of which the symbol exists to this day. It shows the sun's disk, from which extend numerous rays, each ray ending in a hand or hieroglyphic, signifying Life, a true representation of the life and health-giving properties of the sun. It must be clearly understood that there was no idolatry in this. The symbol itself was not worshipped, but rather the life-giving, the intangible essence, which it typified. Herodotus, nearly two thousand four hundred years ago, has left it on record that light was regarded by the physician who knew his business as a prefatory means of repelling illness, and as a subsequent aid to recovery.

When Rome was at the height of her greatness sunlight treatment was prescribed by her fashionable physicians; and we read that Celsus, in the reign of Tiberius, recommended sunlight for those who are debilitated, corpulent, or suffer from dropsy; but he says, 'not too much, lest it bring on fever.'

One could quote for a long time from ancient authorities, and bring evidence to show what was thought of the value of sunlight in those days. But it is to Isaac Newton and his epoch-making discovery of the spectrum a little over one hundred years ago that we owe our knowledge

and our ability to utilize light in a scientific manner. We are now able to recognize and use a series of radiations, differing in respect of wave-length and frequency of vibration. The colours seen in the spectrum range, as we know, from red, through orange, yellow, green, blue, indigo, to violet. The rays above the violet are known as ultra-violet, those below the red as infra-red. These three rays, the ultra-violet, the red, and the infra-red, are those which are used in medicine to-day. The St. John's Clinic and Institute of Physical Medicine, conducted under the patronage of the Venerable Order of St. John of Jerusalem, was the first institute in this country to employ artificial sunlight. Here clinical instruction and teaching were first given, and the examination of candidates, with the granting of certificates of proficiency in treatment by ray therapy to successful students, was first carried out.

Artificial Sunlight

The growth of our knowledge and use of artificial sunlight in the last ten years can only be described as prodigious. It is difficult to tabulate or even to estimate the many ways in which the use of these rays has progressed during quite recent times. This advance has not been marked by milestones; but resembles rather a shower of meteorites. Sunlight centres have grown up all over the country; many devoted to infant and maternal welfare, others to industrial prosperity. Artificial sunlight has been, and is being, installed in general and special hospitals, a comparatively recent development being its use in mental hospitals. It is applied commercially to food-stuffs, and notably to milk. This was demonstrated at the World's Dairy Congress in London in the autumn of 1928, where the efficacy of irradiated milk in the prevention and treatment of rickets was shown. Since then there seems to have been no end to the commercial uses to which it has been put.

Light rays are being used, too, in the training of athletes; though this is ancient as well as modern history, for Philostratus tells us that the athletes of Greece, entering for the Olympic Games, were ordered to take sun-baths as an essential part of their training.

Artificial sunlight has its uses in veterinary medicine. Horses and dogs are alike receiving its benefits. Stock-breeders are using it, more especially those breeding pigs and poultry. And, quite apart from these and other commercial uses, public opinion is turning more and more towards the prevention of illness, and, to that end, towards the promotion of health by light rays. Not that this, again, is anything new, for Hippocrates, who was born nearly five hundred years B.C., pointed out the favourable effect of sunlight and its use in the preservation of health. To-day we may point to the establishment of municipal quartz-light baths in many cities and towns—Bradford, Leeds, Castleford, Bingley,

Stockport, Dundee, Hull, and many others. These are centres for sun-bathing for the healthy rather than clinics for the treatment of disease; and their number increases month by month. Light treatment, indeed, is being administered, not only by the specialist, but by the general practitioner, and by the patient himself, and by all kinds of clinics and establishments, some under medical control, others not. In private it is employed alike by those who should and by those who should not use it.

Radiation is to-day in almost universal use, administered sometimes scientifically, sometimes empirically; but as our knowledge of the physical qualities of this energy increases and as its biological action becomes better understood, so will the empiricism fade away and a science emerge; a weapon forged both for the attack upon disease and for the defence of health. Treatment by ray therapy is to-day not only a necessity of medicine, but an essential in the cure and prevention of disease.

Light is not easy to define, although Sir Oliver Lodge has described it as 'an electro-magnetic disturbance of the ether,' nor is it necessary so to do; but in order to get even a superficial grasp of the subject it is well to glance at its scientific basis.

Natural sunlight is made up of several kinds of light rays; and besides these we already recognize the existence of Hertzian and wireless waves, X-rays, radium rays, and others. All these rays at present can be arranged so that they follow one another in a continuous electro-magnetic spectrum, according to their wave-lengths.

The infra-red rays are the heat rays, and although they have been known for so long, their therapeutic worth has only just been recognized. Some of the good results obtained previously from light and radiant heat treatment were undoubtedly due to the infra-red rays included in the application. The ultra-violet rays occupy a small band immediately above the violet end of the visible spectrum. Ultra-violet rays embrace the actinic rays, which have the power of exciting chemical action, and of producing photographic effects. The velocity of all radiant energy transmitted through a vacuum is the same: one hundred and eighty-six thousand three hundred miles per second. By dividing this figure by the wave-length, the frequency of vibration is obtained, and thus the shorter the wave-length the greater the frequency.

Ultra-Violet Rays

That sunshine is absolutely essential to our well-being is evidenced by the general feeling of depression and of 'being out of sorts,' which is so common towards the end of the winter months, or when there has been a long succession of sunless days.

Sunlight is very rich in ultra-violet rays, but the shorter wave-lengths —which are those mainly used in 'therapeutics' (derived from a Greek word meaning 'to treat medically')—are absorbed by the atmosphere, whilst by the pall of smoke and dust that overhangs our great towns and cities still more rays are cut off, so that the town-dweller seldom, if ever, receives an adequate amount of ultra-violet radiation.

There is no better cure for many ailments than natural sunlight treatment, or heliotherapy; this is carried out at its best in Switzerland, at such clinics as those of Bernhard at Samadan and Rollier at Leysin. In the clear mountain atmosphere the sunlight is particularly rich in ultra-violet rays, the sun shines for many hours daily, and its light is little obscured by smoke or mist.

Heliotherapy is hardly possible to any extent in this country, owing to our fickle climate. Sir Henry Gauvain has achieved great success in the treatment of children at Alton and Hayling Island; but, even there, with the highest sunshine average in England, it is necessary at times to have recourse to artificial aids when sun is too long absent.

Artificially, ultra-violet rays are produced by means of the electric arc. Finsen, the pioneer of this form of treatment, adapted the open-arc lamp once used in street lighting; in it carbons impregnated with chemicals which increase the ultra-violet output are usual; in other types tungsten or iron electrodes. In the closed-arc lamp the arc burns in an atmosphere of mercury vapour enclosed in a sealed fused quartz tube. Quartz is necessary because ultra-violet rays for the most part will not penetrate ordinary glass. Knowledge of this fact has led to the production of special glass which is permeable to ultra-violet rays, the best known being Bita glass. This glass is now often used for the glazing of windows in nurseries, schools, bathrooms, and the bedrooms of chronic invalids, and enables those much indoors or absolutely confined to the house to receive a modicum of natural ultra-violet radiation. The effects of ultra-violet radiation on the body may be divided into general and local.

Generally, it acts as a tonic and stimulates all the natural processes of the body. The blood is enriched and its calcium, phosphorus, and iron content is augmented; the stability of the nervous system is increased, and the ductless glands, such as the thyroid, are rendered more active. Ultra-violet rays have a profound effect on nutritional disorders due to deficiency of vitamins in the diet; and have a specific effect on rickets, which is essentially a disease caused by lack of sunlight and a deficiency of vitamins—particularly of Vitamin D. Ultra-violet ray treatment is also very successful in cases of tuberculosis of the bones, and a large number of cures are obtained.

Locally, the first effect noticed is an erythema of the skin, that is, a redness, which appears some time after the application of the rays.

When the body is repeatedly exposed to these it gradually becomes brown; this pigmentation of the skin being Nature's defence against too great a dose of the rays. In fair people pigmentation may not occur, and the skin may become intensely reddened and subsequently peel. Such a result may also follow an overdose of the rays. In the treatment of skin diseases, such as psoriasis or eczema, a dose is frequently given to promote desquamation. Ultra-violet rays are bactericidal, and hence are used in the treatment of septic wounds, boils, and sluggish ulcers, and are of prime value in the treatment of skin diseases of infective origin.

As a general rule, in applying the rays, the initial dose should be small in order to avoid too intense an erythema. Many factors control the dosage, which can only be learnt by experience. Special care must be taken in the treatment of the very young and the very old, as they appear to be particularly susceptible to the action of the rays. In certain cases it may be necessary to produce an intense erythema, even to the point of blistering; a reaction of this type, provided that the area treated be small, subsides in a short time, and no permanently injurious results occur. But a severe erythema should on no account be obtained over a large skin area, for the effects produced will resemble closely those following an extensive burn, and may be severe; so much so that not many years ago a woman died from a duodenal ulcer that had been induced by a gross overdose of ultra-violet rays.

It is clear from these facts that ultra-violet rays, though a 'natural' remedy, are not to be handled carelessly or by the inexperienced. Properly handled they can be of inestimable benefit to the human body, but it must not be forgotten that they are protoplasmic poisons. If none of the rays leaving the sun were filtered out by the atmosphere before its light reached the earth life could not exist. As great care must be taken in the use of even the simplest 'home' sun-lamp as with any other electrical machine. Already several lives have been sacrificed because proper precautions have not been taken. It is dangerous to instal a lamp in the bathroom; for, with the wet floor, and with the bath and water-taps within reach, there is grave danger of an 'earth' being established as the lamp is switched on, a dangerous, perhaps fatal, current passing through the body of the person operating the lamp.

We may now consider in more detail the ultra-violet ray in: (1) Health; (2) Disease, chiefly for (*a*) certain skin diseases; (*b*) treatment and prevention of rickets and bony tuberculosis; (*c*) relief of pain.

ULTRA-VIOLET RAY TREATMENT IN HEALTH.

Let us first examine for a moment the meaning of the phrase, 'treatment in health,' and endeavour to define it. Treatment in health is the keeping of the body and mind healthy, and the prevention of disease.

It implies such treatment as will keep well people well, in contradistinction to such treatment as will make ill people well. It is no small matter to keep people well, rather than to make them well; not only to keep them fit, but to make them fitter; to maintain and create that feeling of well-being which should be ever-present in every human body; to enable them to feel the joy of play, the joy of work, the joy, indeed, of just being alive. Many examples could be brought in evidence as to the value of ultra-violet radiation in the treatment of health; but one series of cases must suffice. Some nine or ten years ago ultra-violet radiation was established, under medical supervision, by the management of the Theatre Royal, Drury Lane, for the benefit of any one connected with the theatre who wished to avail himself of its advantages. There was no question of treating illness or disease; the clinic was installed solely for the purpose of keeping the artistes and staff fit and well. The results have been most satisfactory. The first report, made some fourteen months after this installation of ultra-violet light in the theatre, mentioned that among those who had used it not one artiste had been 'out of the bill' for a single performance, while of those who had not visited the sunlight department nearly every one had, during the very long run of the piece, either missed one or more performances through 'catching cold' or similar causes, or had fainted, or had otherwise shown some sign of ill-health. Since the inauguration of 'sunlight' at the theatre several plays have been produced and had long runs, and it is an interesting fact that all those whose names appeared in the list of sunlight takers during the run of the first piece were in the cast of the following production, and several have since been re-engaged for each successive piece. More than one sunlight bather has been promoted from chorus to small-part character, and, as it is known that one of the actions of artificial sunlight is to increase mental activity and improve muscular agility, may we not allow ourselves to believe the artificial sunlight to have been a contributing factor in the success of these actors and actresses?

Space will not permit of the detailing of the Sherwood Colliery report; but it may be stated briefly that after a course of three months' treatment by ultra-violet rays a group of fifty boys showed an average gain in weight per boy, double that obtained in a control group, not so treated; and an increase in height amongst the treatment group of 50% over that of the control group.

So much by way of a very brief summing-up of the value of ultra-violet rays in the treatment of health. It may be asked how it is that this form of therapy is of such universal benefit. Why does it suit everybody? These questions may best be answered by asking another: Does a holiday visit to the seaside suit everybody? Does not such a

change of air make for health? Does it not brace every one up for the whole working year, and produce a more cheerful outlook upon life in general? From a visit to the high Alps of Switzerland or the Pyrenees, where ultra-violet rays reach us more freely, the benefit we may expect to derive is even greater. In fact, within wide limits, the more sunlight, i.e. the greater the proportion of ultra-violet rays, the greater the potential health-gain.

ULTRA-VIOLET RAY TREATMENT IN DISEASE.

We come now to the uses of ultra-violet radiation in disease. It was in affections of the skin that it was first used (by Finsen), and it is in diseases of the skin that it has been used more than in any other class of disease. Probably more cases of lupus—the dermatological condition in the cure of which it was first employed—have been treated by ultra-violet radiation than of all other skin diseases together. These rays can be profitably applied in a great variety of diseases of the skin, and the reason for this may be found in a pronouncement of Radcliffe Crocker in 1913, in which he stated that the key-note of the modern treatment of skin diseases is antisepticism. Every surface that is exposed to ultra-violet radiation is thereby rendered antiseptic, so that one reason for its efficacy in a great variety of skin disease is clear. It has been said that this treatment is useful in all skin diseases from A to Z (Acne to Zoster, one may presume); but certainly in acne, in alopecia areata (baldness in patches), in boils, carbuncles, eczema, herpes (shingles), impetigo, psoriasis, pruritus, and many more, ultra-violet radiation is one of the most valuable agents in the hands of the dermatologist.

The next, and perhaps even more important, field of usefulness for these rays is where we have to deal with rickets, and with the tuberculosis of joints and bones. Their success in the treatment of rickets is more than encouraging. It envisages a future in which the disease may disappear entirely.

Not only in bony defects is the general use of ultra-violet radiation indicated; but the flabby, hypotonic child is enormously benefited by it, the dull, apathetic child becomes brighter, the lazy more energetic, and the irritable, fractious child more amiable and cheery. Ultra-violet treatment is now not only recognized as specific for rickets, but is being used more and more—and with success—in those conditions which are associated with, or often precede, the condition of recognizable rickets. These are seen in children with chronic, running, snivelling colds, pale faces, and white flabby skins, who look anaemic and marasmic, and often sound as though they suffered from adenoids and enlarged tonsils—as indeed they probably do. At this stage of incipient disease, ultra-violet ray treatment often acts as an efficient preventive.

One condition out of the many in which ultra-violet radiation is of value is that of pain. The pain-relieving quality of radiation, and it is a very important therapeutic quality, is but little known, less used, and very difficult to understand; and though it is a fact that radiation will often relieve pain, be it superficial or deep, the exact manner in which this result comes about is at present unknown.

It may be that the rays exert some biologic action in the vicinity of the irradiated nerve-endings, and that it is this that constitutes their analgesic quality. The relief of pain in the deeper structures may be due to one of two causes, or possibly both. It may be due to the superficial hyperaemia produced, or to the peripheral nerve irritation causing a reflex action between the many areas of cutaneous surface, and the various internal organs.

The Red and Infra-Red Rays

The red rays are, as has been stated, the lowest rays of the visible spectrum. Their use in medicine is recorded in the *Rosa Medicinae* of John of Gaddesden (1280?–1361), who, in the treatment of a case of smallpox, excluded all visible light, except the red. Red rays have a power of penetration greater than that of ultra-violet radiation, but not so great as infra-red radiation.

A little recognized fact is that patients get some infra-red rays from the sun and the various lamps in use, whether they be of carbon or tungsten arc, or of the quartz mercury vapour type. Indeed, a table published by the Bureau of Standards (Washington, May 1926) shows that the quartz mercury arc lamp, usually credited as a pure ultra-violet lamp, emits approximately ten times as much red and infra-red as it does ultra-violet radiation.

One of the conditions in which it is reported that red rays have been found useful is in the restoration, by their means, of atrophied muscles. The cases on record are of infantile paralysis, in which the muscles had lost their power of contractility, and had resisted all other methods of treatment. Radiation of pure red rays was administered, and the muscles thus treated not only regained power of movement, but gave a ready response to electric stimulation. These results were attributed to the absorption by the muscles of red radiation, and this produced in the tissues an increased power of resistance and repair, together with an improved nutrition. But not so much work has been done with the pure red rays as with their neighbours, the infra-red rays. Primarily they are heat rays; as a matter of fact, heat may be said to be the absorption of the infra-red rays by, and in, the human body.

The use of these rays considerably antedates any scientific knowledge

of them. In and from the days of Hippocrates history relates cases of pain being relieved by heat from a burning brazier, or heated flat-iron, or from the sun's rays focused by a burning-glass.

In 1776 Dr. Faure claimed great success in the treatment of old ulceration by the use of a live coal, which he alternately approached to and withdrew from the afflicted part, the patient controlling the proximity of the coal according to the heat which he felt. In the Navy, we have been told, if a stoker burnt himself on a steam-pipe he immediately opened the furnace door and exposed the affected part to the blazing fire. It is probable that the relief from pain in all these cases was due to the action of the infra-red rays. Pain is, perhaps, the chief indication for the use of this form of radiation, and the relief obtained from its use is often remarkable.

The following is an incomplete and unclassified list of cases of pain in which infra-red radiation has proved successful: lumbago, stiff neck, and other myalgias, neuralgias, facial neuritis, intercostal neuralgia following shingles, and acute cases of neuritis, such as sciatica.

Infra-red rays have been found useful in post-operative peritoneal adhesions, the results being due to the power of the rays to cause resolution or absorption of pathological infiltration.

In the dull chronic pain of an inflamed gall-bladder infra-red rays will often relieve the patient, and similar relief from pain has been obtained from their use in chronic pelvic lesions.

It is not to be thought that radiation is a panacea for all the ills to which flesh is heir. It is only one more weapon in the armoury of the fully equipped physician. Properly selected cases, treated with correct technique, will have their time of treatment shortened, if radiation be employed; and this form of therapy will help to cure obstinate cases, which might otherwise continue without relief.

XXIV—SOME MINOR AND SOME COMMON AILMENTS

It is very difficult to say what is a minor ailment. What little we know about the serious diseases of mankind teaches us that they nearly all have their beginnings in symptoms seemingly of the most trivial nature. People speak of a headache, or a common cold, or a sore throat, or a stomach-ache, as a minor ailment. So it may turn out to be; but we know that it is as a stomach-ache, or a sore throat, or a cold, that many of the gravest and most fatal of human disorders first manifest themselves. It is time that we stopped using such phrases as 'just a cold,' or 'merely a touch of indigestion,' or 'probably neurotic,' as though these things were entities of no sufficient significance to disturb our equanimity. No ailment that fails to disappear in the course of a few days can be safely dismissed as trivial and unimportant. A prick with a pin or a thorn may well be the precursor of a general septicaemia that ends in the loss of a limb, or even in death; a sore throat may be the first indication of diphtheria, or of possibly lethal streptococcic infection. Therefore, it is unwise to regard any manifestations of disease as minor or insignificant if they persist for more than a very short time; for there is very little obvious difference between the onset of a grave disorder and that of an evanescent one.

One hesitates to advise the amateur as to the appropriate treatment of minor ailments; mainly because it is by no means easy for an untrained person to distinguish between a minor ailment and one potentially serious in its consequences. In every household, however, there are constantly occurring small injuries and slight disturbances of health for which it would seem unreasonable, indeed, ridiculous, straight away to send for the doctor. A child falls and scrapes its knee; some particle blows into the eye; one is bitten by an insect, or stung by nettles; a knife may slip and the finger be cut, or a little boiling water may be spilt on the foot. These and the like are everyday incidents everywhere, and, nine times out of ten, a little prompt attention, rightly directed, quickly puts things right. There is, however, one rule which should ever be kept in mind. Whenever an injury or an illness is even suspected of being potentially serious, or when a minor injury or ailment does not quickly respond to simple remedial measures, a doctor should be consulted without delay. When in doubt send for the doctor. Medical art is far from omnipotent, but almost every doctor, by reason of his training and experience, inevitably knows more about the nature and about the possibilities of accidents and illnesses of every kind, than can the most intelligent and best instructed layman.

ABSCESSES

The process of inflammation, and the formation of abscesses, are explained earlier in this book. Here, it is sufficient to say that, whenever local inflammation shows itself by the classic symptoms of redness, swelling, and pain, one may suspect the beginning of suppuration, and the possible formation of a localized abscess. If the condition lasts for more than a day or two, medical advice should be sought, as this condition is much easier to deal with at an early stage than when the responsible poison has spread to deeper and more inaccessible parts. The immediate treatment consists in the prolonged bathing of the affected part in warm water, alternating this process with the application of warm boracic fomentations. It is practically impossible for the layman to decide when is the right moment for the abscess to be opened if this becomes necessary or expedient.

ACNE

Among the surface defects to which youth is peculiarly liable, none is more frequent, and few are more disfiguring and disconcerting, than those which are due to the disorder called acne. This disease is responsible for the appearance of those unpleasing papules popularly known as blackheads; though, as a matter of fact, they are as often white, or skin-coloured, as black. These swellings are caused by a blockage of the openings of the minute tubes leading from the sebaceous, or oil, glands, which are thickly distributed over our face, chest, shoulders, and scalp. It is almost exclusively on these parts that acne shows itself. On the palms of the hands and the soles of the feet, for example, from which sebaceous glands are practically absent, acne never appears. It may, indeed, be recognized by its distribution. When papules appear in any quantity on parts of the body other than those named, we may be pretty sure that something other than acne is responsible. Acne is much commoner in young manhood and young womanhood than in childhood or old age. It is likely, therefore, that there is some connection between this disorder and the activity of those endocrine glands that come into operation at puberty. It is not irrelevant to note that it is at that age, also, that a stimulus is given to the growth of hair, for it is then that the beard first manifests itself; and the sebaceous glands have a close association with the hair sockets. Those individuals who have coarse, oily skins are particularly prone to this surface affliction; and it is they who are most bothered with scalp troubles such as scurf and baldness. That blocking of the sebaceous ducts is in part due to excessive oiliness is suggested by the fact that motor mechanics, and others whose work makes them particularly liable to get oil about

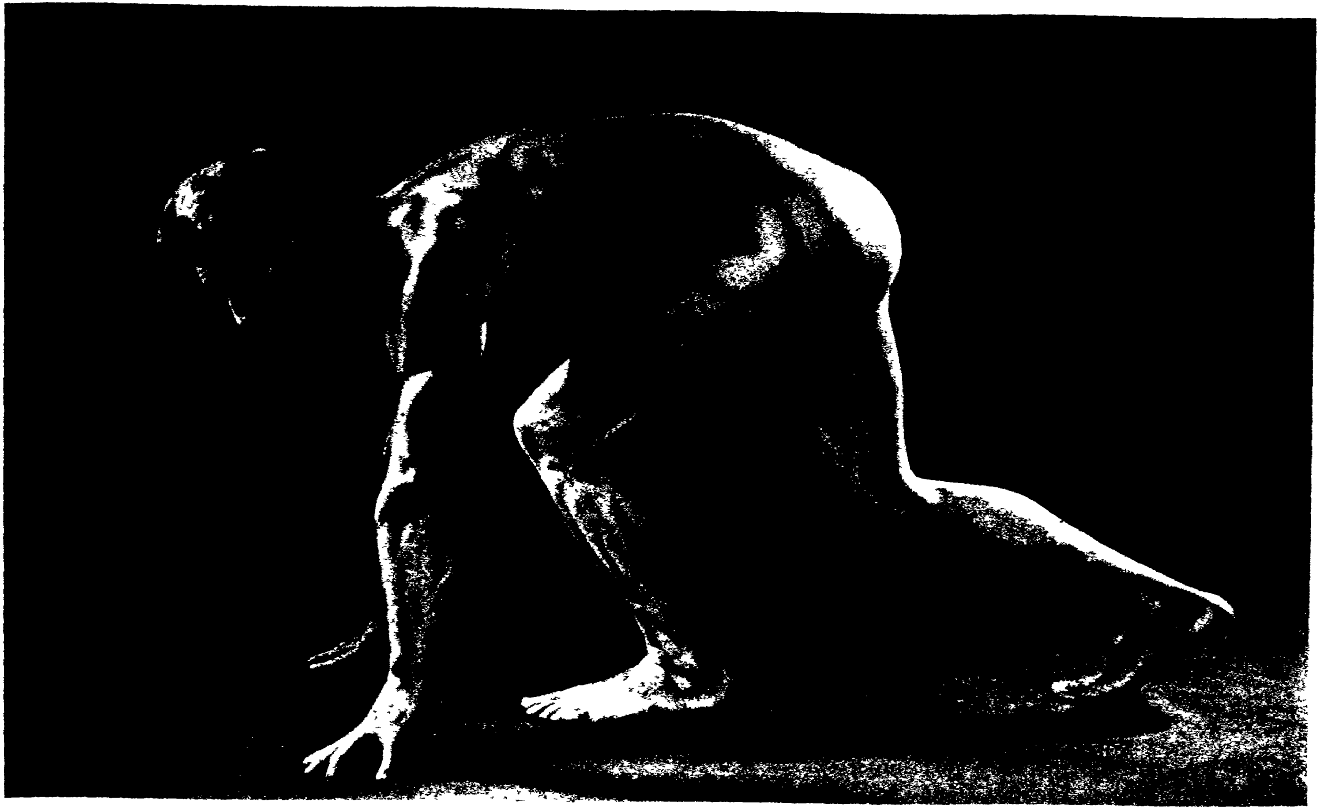


Photo by Herbert Williams

MAN AS QUADRUPED

. . . the way in which protection is

their skins, are not infrequently subject to acne on parts of the body not usually affected. The regular and vigorous use of soap and water, morning and evening, is probably the most effective single preventive measure to be taken. Active outdoor exercise, and the careful regulation of the bowels, are also important. Assuming that acne is already present, the face should be vigorously scrubbed three or four times a day with warm water and coal-tar soap; then rubbed dry with a towel; an equal mixture of water and glycerine-of-boric-acid being rubbed into the skin after the drying. Plenty of salads should be included in the dietary, and a quart of water should be drunk daily between meals. In many cases, a course of thyroid extract is desirable; but this should not be taken except on the advice of a doctor.

Barber's Rash

Barber's rash, or sycosis, essentially consists in the formation of tiny abscesses or pustules in the follicles of the hairs of the face. It is usually quite a superficial condition; and, if actively and properly treated in the beginning, is not really difficult to get rid of. Its name is a little unfair to an honourable craft. Nine times out of ten when a man finds himself affected with sycosis, he puts the blame on the barber who last shaved him, and generally accuses him of lack of cleanliness. Sometimes this accusation is just enough; but it by no means follows that, because a septic inflammation of the hair follicles occurs soon after, or even in consequence of, a recent shave, the germs causing the disease were present on the shaving brush, or on the surface of the razor employed. It is at least as likely that they were present on the surface of the skin, and were merely afforded ports of entry by the action of the razor. As a matter of fact, experience shows that barber's rash rarely affects men who never shave, or men who shave every day. It seems to be generally those who shave occasionally—once or twice a week—who are specially liable to the infection. An effective way of treating the disorder is to shave daily, and twice a day to wash the face with water and coal-tar soap, drying the skin with a towel, and then rubbing in an equal mixture of glycerine and solution of corrosive sublimate of a strength one in one thousand. Nearly always, if this treatment is persisted in for a week or two, the disease clears up. If it does not, a skin surgeon should be consulted.

Boils and Carbuncles

Boils and carbuncles, though often treated as minor ailments, may easily lay the train for a sequence of very serious, even dangerous, pathological conditions. It is unnecessary to describe their surface

appearance. The great difference between them is, that the carbuncle penetrates deeper into the surface tissues and, consequently, is more likely to infect the rest of the body. When it has 'burst,' it is recognizable by the fact that pus exudes from it at many points, whilst boils discharge from one point only. There are always present on the skin, and floating on the particles of dust which constantly fall on it, germs which are the active agents in the formation of boils and carbuncles. When we are in good health our blood promptly deals with any of these germs that succeed in passing through our protective covering, the skin. But, if the germ-destroying powers of the blood fall at any time below normal and, at the same time, some abrasion of the skin, be it ever so slight—as by the rubbing of a collar or of the chair on which we sit—occurs, germs provocative of boils or carbuncles may effect an entry and establish themselves. The resulting combat between these germs and the defensive forces of the body results in the formation of the localized abscess which we call, according to its position and nature, a boil or a carbuncle.

If the constitutional symptoms consequent on these local disturbances are pronounced it is wise to obtain medical advice without delay. In milder cases the following line of treatment may be adopted. The abscess itself should be fomented with hot boracic lint, and the patient should take an effective saline purge. The fomentations should be repeated every two hours or so. In no circumstances should a boil or carbuncle be squeezed by the fingers, or the poison may be pressed into deeper parts, and so enter the general circulation. If improvement is not very soon noticeable, a doctor's advice should be obtained. Incision at the right moment may prevent a dangerous situation—may, in fact, even save life.

Nephritis and, even more markedly, diabetes are apt to reduce the blood's bactericidal powers, and thus favour the formation of boils and carbuncles whenever infection occurs.

Bunions

Through the use of high-heeled and pointed shoes, the weight of the body, in standing and walking, crowds the toes together into the front portion of the shoe. This crushes the transverse arch of the foot, and at the same time presses the big toe inwards towards the other toes. The head of the metacarpal bone on which the big toe articulates, protrudes till it lies just under the skin, and devel0ps a corn or callosity on its surface. Under the callosity there is usually a small bursal sac, a condition similar to that which arises in housemaid's knee. The bunion, when complete, is a structure of bone, bursal sac, and corn. Wide-toed shoes, with low heels and with a wedge or 'toe-post' rising

from the inner surface of the sole between the big toe and the next, help in lessening pain and discomfort. Pads worn round the bunion to shield it from pressure also give temporary relief. Special shoes with a bulge in the leather to take the bunion can be obtained. Bad cases need the surgeon's attention.

CHILBLAINS

There are two distinct types of people who have what has been called a 'chilblain circulation.' On the one hand are those stoutish individuals, most commonly young women between the ages of fifteen and thirty, whose general physique, expression, and movements suggest placidity, sometimes amounting to sluggishness of mind and body. This class includes those young women, more in evidence since the popularization of artificial silk stockings, who suffer from cold, swollen legs, which tend to go purple as soon as autumn is over, and scarcely recover a healthy colour until the following spring. The other type is quite different in appearance. Lean and temperamentally active, often to the point of irritability, nothing could be more unlike the group described above; but, in spite of their activity, these people are no less subject to cold hands and feet and ears whenever the outside temperature is below the normal. Clearly, then, in addition to cold, there is in some people an individual element or idiosyncrasy which makes them susceptible to conditions which have no effect upon other people. Whatever the determining factor, the immediate cause of chilblains is a local loss of tone in the minute blood-vessels or capillaries, due to the impact of cold on the surface nerve-endings. It is possible that the ultimate cause varies in different individuals; both the endocrine glands and the nervous mechanism regulating the circulation being involved.

The taking of regular active outdoor exercise is, perhaps, the most important preventive measure; as it is one of the most helpful in curative treatment. Those with a tendency to chilblains should keep the extremities warm. Young women who deliberately, after recurring annual experience of this crippling ailment, cover their legs in the coldest winter months with but the thinnest of silk stockings, deserve what they get. Thick woollen stockings, wide easy-fitting boots or shoes, with low heels and substantial soles; warm woollen or fur-lined gloves, and sensibly warm clothing generally, make up the only sane winter costume for all who possess a chilblain circulation. It is probable that diet, also, can play a helpful or a harmful part. It is wise to include among our daily foods a fair amount of milk or other animal fat; of wholemeal bread; and of fresh fruit. Chilblains having actually appeared, some local treatment is called for. When the skin is unbroken, painting with collodion is sometimes useful; so, also, are

preparations of iodine and of friar's balsam. Broken chilblains, which do not quickly respond to mild antiseptic applications, call for the doctor's attention. The drug treatment of chilblains is often of secondary importance; and, in any event, had better be left to the doctor, who can discriminate between the needs of different cases. Perhaps the most effective of the medical agents commonly employed are, for the first type described, thyroid extract and iodine; and, for the lean type, lactate of calcium in association with extract of parathyroid gland and cod-liver oil.

CONSTIPATION

The problems associated with constipation have been discussed at some length in other parts of this book. Here, it suffices to say that there is no common manifestation of bodily disorder that is responsible for a greater measure of discomfort, inertia, and general malaise, than is that dilatoriness of intestinal elimination which we call constipation.

Constipation which resists simple remedial measures calls for the doctor's intervention; but, seeing how widespread is the condition in these civilized days, it is desirable that every one should acquaint himself with the elementary facts relevant to its cause and to its remedy.

The refined foods of civilization, and the sedentary life imposed on so many of us by contemporary industrial organization, are, perhaps, the most common root causes of habitual constipation. Our food, nowadays, bears small resemblance to that of our primitive ancestors; and but relatively few of us take anything like the amount of active outdoor exercise that was almost universal among our forbears. The peristaltic movements of the bowels are largely a response to internal tension; consequently, the more we refine our foods and lessen their bulk, the less the intestinal tension and the less the stimulus to intestinal activity. It is in an endeavour to make good this defect in our diet that many hygienists recommend the taking as medicaments either of certain indigestible bran-like substances, or, alternatively, of other substances such as agar-agar, which swell up in the alimentary canal, and so provide the stimulus lacking in an all too digestible dietary.

The general principles involved in the treatment of constipation are comparatively simple. By a more active outdoor life we should endeavour to bring up to its optimum our general muscular tone. We should, at the same time, endeavour so to modify our daily dietary as to increase the bulk of our intestinal contents in unharmful ways. It is undesirable and, in some degree, dangerous, to resort straight away to the use of strong purgative drugs which rely for their action on the chemical irritation of the nerve-endings situated in the delicate lining membrane of the bowel. Such purgatives are necessary on occasion;

but they should be the last, not the first, to be selected from our armoury.

It is the diet which calls for earlier consideration; and, here, care should be taken to include in our meals of every day a generous supply of uncooked saladings, such as lettuce, tomatoes, watercress, and so on; a reasonable amount of cooked green vegetables, and a sufficiency of fresh fruit. Liberal quantities of water should be drunk between meals—a quart being a reasonable daily allowance; and wholemeal bread, or one of the various whole-grain crisp breads now available, should replace white bread. If the constipation is of longish standing these measures may not at first suffice. In such event it is well to take every morning immediately on waking an adequate dose of one of the saline aperients—some of the effervescent preparations are the most agreeable—in half a pint of water, following this potation after a short interval by the drinking of a generous cup of tea or coffee. If even this combination of measures proves ineffectual, a further piece of self-medication may be attempted by the taking every night for a few weeks of a compound aloin tabloid. These drugs, however, should be regarded but as a temporary expedient, resorted to merely to establish habit. In any case, the various dietetic and hygienic measures enumerated above should be adopted from the beginning. Constipation so severe and persistent that it does not satisfactorily respond to the combination of measures here advised calls for the ministrations of the doctor.

Corns

The surface of the body is covered by several layers of epithelial cells. The nearer they are to the surface the flatter and the harder they get, in preparation for their eventual shedding. This flattening and hardening is called cornification. At certain sites, especially the soles of the feet and the palms of the hands, the skin is harder—more cornified—than at others. If any portion of the body is exposed to continued pressure the skin covering that part hardens still more. The soles of normal feet are so constructed that pressure is evenly distributed over their supporting surfaces. Owing, however, to fatigue, to disease, or to ill-fitting boots or shoes, pressure may bear unduly on one point, causing pain in the underlying soft parts. It is to protect these soft parts that a corn is formed. Nature, however, is apt to overdo the cornification, so that the corn itself becomes a source of discomfort—often extreme.

To cure a corn the first thing is to deal with its cause—that is, to remove pressure from the affected area. Wide, easy-fitting shoes must be worn and, if necessary, a corn plaster should be applied to protect the tender point. The corn and its surroundings may need to be cut

away by an experienced chiropodist. Sometimes it is sufficient to keep the corn painted nightly with a solution containing a drachm of salicylic acid and fifteen grains of cannabis indica, made up with an ounce of flexible collodion. During the time the paint is being applied the foot should not be washed, or the application will come off. Often it will be found that the corn peels off readily after it has been completely dehydrated by this treatment.

Flat-foot is certainly responsible for many minor foot troubles—amongst them corns on the soles of the feet and on the knuckles of the toes. All sorts of postural defects associated with flat-foot are treated of in another section of this book. Over-fatigue, too much standing without walking, neglected sprains, and rheumatism, are all potential causes of the condition. Much can be done to remedy it in its early stages by suitable rest and by special exercises, elsewhere described.

Cracked Fingers

During the winter months many people suffer from a rather distressing and very discommoding condition, which takes the form of fissures, more or less deep, in the skin of the fingers and hands. It is a good plan to bathe the hands at least four or five times a day for a few minutes in warm water, to dry them thoroughly, and then to pour into the palm of one hand a little of an equal mixture of water and glycerine-of-boric-acid, and thoroughly to rub this into all the fingers and into the skin of the back and palm of each hand. In very bad cases it may be necessary in addition to rub into the skin of the hands a little lanoline every night before going to bed and, during the sleeping hours, to cover the hands with white washable cotton gloves.

Dandruff and Falling Hair

Dandruff, or scurfiness of the scalp, is not uncommon among both men and women of all ages. Associated with it is not infrequently an abnormal falling of the hair and premature baldness. There is no doubt that this condition is commoner to-day than in the past; but the actual cause or causes are somewhat obscure. In many cases unusual bacterial activity seems to be responsible; in others, the trouble is apparently connected with some disturbance of the functions of the sebaceous glands. It is likely that general bodily condition plays a leading part in causation; though, in the absence of more precise knowledge, no guidance as to treatment has been inferred from this presumption.

Everything possible should be done to improve the general health

by means of outdoor exercise, a simple generous diet including plenty of salads, and reasonable exposure to sunlight. Locally, the following treatment should be adopted. Brush the hair vigorously two or three times a day; twice a week rub into the scalp an equal mixture of olive oil and common lamp paraffin, washing the head the next morning with warm water and coal-tar soap. On all the other nights rub into the scalp a little of the following lotion: boric acid, one drachm; glycerine, one ounce; water to eight ounces. A course of thyroid extract, in small doses, is often helpful; but this should only be taken on the advice of a doctor.

Temporary Deafness

The mechanism which enables certain vibrations of the air to stimulate special nerves connected with our brain, as a result of which we hear and discriminate between what we call sounds, is described and illustrated elsewhere. Ordinarily, the recognition of any degree of deafness should impel us to seek the advice of a doctor specially skilled in dealing with this part of our physiology. Not uncommonly, however, a person who has always heard as well as do other people notices that, without any history of illness, his hearing is less acute than it was. Reasonably, he may not feel inclined to rush straight off to an aural surgeon—at any rate, until he feels a little more sure that there is something seriously wrong.

One of the commonest causes of temporary deafness is the presence of impacted wax in the ears. This prevents aerial vibrations from falling on the drum, with the result that more or less complete deafness is experienced. In the lining of the outer ear-passage are a number of little glands whose business it is to secrete or manufacture wax, with which the surface of the tube is always thinly coated. The seeming purpose of this wax is to trap particles of dust and tiny insects before they reach the sensitive drum. Normally, this thin coating of wax dries up and disappears without our noticing it. Occasionally, however, an excessive amount of wax is formed, or perhaps, though only a normal amount is manufactured, it does not become detached from the membrane, but remains as a basis for fresh accumulations on top of it. Then, one day, often through a little water entering the ear-passage whilst we are washing our face, the wax swells up and completely blocks the airway. Deafness, giddiness, and sometimes pain result. The condition is readily curable, but the cure should not be attempted by uninstructed amateurs. Unless someone in the house has actual experience in the use of an aural syringe, and a proper aural syringe is itself available, it is far better to visit the doctor, and let him deal with the trouble. Assuming that impacted wax is causing the deafness, and

that the ear is to be syringed, whether by a friend or by the doctor, a little peroxide of hydrogen or, as an alternative, a little of an equal mixture of water and glycerine should be dropped into the ear every morning and evening for three or four days. This loosens the wax and makes it more easy to remove. It is very dangerous to poke about the ear with hairpins or with any other implement; serious injuries being not infrequently caused by disregard of this rule. Finally, it is dangerous ever to syringe an ear which is either painful or discharging, unless this treatment is prescribed by a doctor familiar with the facts of the case.

Diarrhoea

Perhaps the most important advice to be given concerning the treatment of diarrhoea is this: if it persists for more than a couple of days consult a doctor. Diarrhoea may be set up by almost any dietetic indiscretion; among the commoner causes being the eating of unripe fruit, or of some food to which one is unaccustomed. It represents, indeed, an attempt of Nature to get out of the body as quickly as possible substances which are uncongenial or unassimilable. Tainted meat, or food infected by the organism responsible for botulism, is a not infrequent provocation; but various germ invasions, such as those of the typhoid bacillus, may also set going excessive peristalsis of the intestinal muscle. If the symptoms are acute, and any general feeling of illness accompanies them, it is wise to seek medical assistance from the start; but, if the case appears to be a simple one, certain first-aid measures may be taken. A dose of castor oil (a teaspoonful in the case of a small child, a tablespoonful for an adult) may be given straight away. As soon as the castor oil has done its work, a teaspoonful of compound bismuth powder may be taken in a wineglassful of water. It is not advisable to drink any milk, unless ordered by the doctor, until the diarrhoea has stopped. Generally it is best to eat no food at all for some hours; though water may be freely drunk.

Ear Discharges

Morbid conditions of the throat and nose often show themselves by discharges from the ear. The ear should in these circumstances be gently cleansed by irrigation with a few drops of peroxide of hydrogen, and by subsequent thorough drying. The hearing is usually improved by this treatment; but it must be carefully carried out, without force of any kind. When the discharge is lessening, a 5% solution of glycerine-of-carbolic-acid, a few drops at a time, once or twice a day, may be used. Boracic powder blown into the ear may be used as an alternative.

Ear discharges may be due to any one of a variety of morbid con-

ditions, many of them very grave; so that such a discharge if it persists for more than a very short time should suggest the wisdom of consulting a doctor. Meningitis, cerebral abscess, and mastoid disease are all associated with aural discharge.

Inflamed Eye

The eye is far too important an organ for the amateur to play with. Superficial inflammations, accompanied by catarrh, are, however, fairly common. Good immediate treatment of any inflammatory condition of the eye consists in bathing it five or six times a day with warm boracic lotion—placing between the eyelids a little yellow oxide of mercury ointment every night. If improvement is not quickly established, a doctor should be consulted.

Inflamed eyelids, the condition known as blepharitis, may be treated much in the same way. If the inflammation is localized, as it is in the development of a stye, warm fomentations may advantageously be applied every couple of hours; the treatment recommended above being coincidently persevered with.

Haemorrhoids or Piles

These should not automatically be regarded as minor matters; for often they are indications of internal disturbances that call for prompt and expert treatment. In itself a pile is a relatively simple affair, being but a varicose vein localized in the lining of the rectum or lower bowel. Persistent constipation is a common cause; but anything which obstructs the return flow of blood from this part of the intestine may bring about a varicose condition. Beyond remedying any tendency to constipation there is little that the amateur can usefully do. Much the wisest thing, if haemorrhoids persist or become painful, is to consult a doctor and to leave the treatment of the disorder in his hands. He may think it wise to remove the piles by excision, or to destroy them by the injection into them of fluids which lead to a clotting of the blood and a fibrosing of the vein walls. The determining of the better form of treatment in persistent cases had, in any case, better be left to skilled persons familiar with the possible complications.

Superfluous Hair

From the narrow hygienic point of view there is nothing alarming about the possession of what is called superfluous hair—that is, hair which, according to current conventions, is not usually present in the particular situation in which it occurs. Elsewhere in this book the

influence of the endocrine glands in determining the presence or absence of what are called secondary sex characteristics, is discussed. But the point which concerns us here is that women suffer considerable emotional distress from the appearance on their faces of hair which is commonly looked upon as inappropriate to their sex. Many chemical compounds are sold purporting to get rid of this disfigurement—if it is one. Some of these depilatories are relatively harmless, and do, for a while, remove the hair much as shaving would do. The only permanent cure for superfluous hair is offered by electrolysis. This process consists in applying a needle connected with an electric battery to the base of the hair follicle, and thus destroying it. Electrolysis should be carried out only by experts, or real and permanent disfigurement may result.

Hoarseness

An acute attack of hoarseness is generally associated with a 'cold,' but it may last after the other symptoms have cleared up. By way of treatment rest the voice, keep out of smoky and stuffy atmospheres, and take no very hot drinks or highly spiced peppery foods. Alcohol is undesirable, and smoking should be dropped, at least for the time. Inhalation of the steam of hot water to which has been added friar's balsam, in the proportion of a teaspoonful to a pint, often helps to soothe the throat; and the homely nursery remedy of lemon-juice and honey is both pleasant and, so far as it goes, remedial. The cough which is almost always associated with the condition needs separate treatment.

Housemaid's Knee

In front of the knee-cap is a sort of sac, consisting of two membranous walls, with a little lubricating fluid between. This is called a bursa. There is a similar bursa at the back of the elbow-joint. These bursae afford protection to the joints adjacent to them; but their powers are limited. They evidently are not devised to stand persistent or repeated pressure. If subjected to such, the membraneous walls are liable to become inflamed, with the result that an excess of fluid accumulates in the joint. Housemaid's knee is the popular name given to such a bursitis in front of the knee-cap or patella. The corresponding bursitis at the back of the elbow is popularly known as miner's elbow because, in the course of their work, miners subject their left elbow to prolonged pressure and, consequently, are peculiarly prone to suffer from this disorder.

The symptoms of housemaid's knee are much as one would expect; viz. the appearance of a swelling in front of the knee, which swelling is

easily recognizable as due to the presence of fluid in an enclosed space. Usually this swelling is painless, but occasionally germs find their way into the bursal cavity and set up suppuration, so that an abscess results.

In the case of a simple patellar bursitis the first thing to do is to stop kneeling on the affected knee. A bandage—preferably a crêpe-elastic one—should then be applied with reasonable firmness round the whole of the knee joint. If this treatment does not, in a week or two, lead to the disappearance of the excessive fluid, or if suppuration—manifested by redness and pain—supervenes, a doctor should be consulted. Probably he will think it expedient to make a puncture into the bursa, and so release the serous fluid, or the pus, as the case may be.

Indigestion and Biliousness

Digestive troubles are fully described in another part of this book, but a word here may be said about evanescent symptoms associated with the stomach and bowel. Persistent digestive trouble of any kind should send the victim to the doctor, for the possible causes of such troubles are many, and the appropriate treatment naturally varies accordingly. Quite often, however, the cause is obvious—some indiscretion in diet, or insufficiency of exercise, may usually be suspected. Often there is a mild toxaemia or blood-poisoning.

What we may call first-aid treatment is comparatively simple. If there is loss of appetite, do not eat until the appetite returns; a day's fast does few people any harm. On the other hand, it is a good plan to sip water, soda-water, or lemon-water frequently and freely. A good spoonful of an effervescent saline aperient, in half a pint of water, is often helpful in ending the attack. More important than the immediate treatment are the steps to be taken to prevent a return. Simple, regular, meals; plenty of outdoor exercise every day; the remedying of constipation, if it exists; the eating of a certain amount of fruit and salads daily; and the avoidance of such things as sweets, cakes, pastry, and new bread, are perhaps the most generally useful preventive measures. But, to repeat, if attacks of what we are inclined lightly to dismiss as indigestion or biliousness frequently recur, they should not be looked upon as trivial. They may be due to conditions which, though remediable at first by surgical or other means, have grave possibilities if disregarded. Gall-stones and gastric ulcer are two serious conditions much commoner than was once suspected. They usually manifest themselves by symptoms which most people describe as indigestion. Other, even more grave, diseases might be named. Therefore, any one whose indigestion persists for more than a week or so, and fails to respond to such simple treatment as a layman may

wisely employ, will be wise without further delay to consult his doctor in order that the true cause of the trouble may be diagnosed, and arrangements be made for its effective remedy.

Migraine

There are few more distressing or incapacitating disorders than the spasmodic and periodic disease known as migraine. Certain individuals are subject to its attacks at intervals of varying frequency; these will not need to be reminded of its symptoms. Other people, who lead very similar lives, are totally exempt from it. The characteristic and most pronounced symptom of migraine is a blinding headache, usually confined to one side of the head. There is marked intolerance of light. An attack is usually marked by profound prostration and mental depression—even thought is painful. Almost always, there is nausea, with a feeling of impending sickness. Often, actual vomiting occurs, especially toward the end of the attack. After vomiting the symptoms usually abate, and very often the victim of migraine falls into a sound sleep from which he, or more often she, wakes up completely well and ready for a meal. Unfortunately, migraine does not always take so speedy a course; hanging on for a couple of days with recurrent sickness and almost continuous headache.

As we do not know much about the real nature or cause of migraine, the treatment of this disorder is little more than guesswork. It seems to be established by experience that a healthy, active, outdoor life, and simple dietary, with the complete avoidance of alcohol, lessen the liability to attacks, though these hygienic precautions cannot be depended upon to prevent them. The slightest tendency to constipation should be remedied, abundance of fresh fruit being eaten daily, and water or lemon-water being drunk freely between meals. A morning saline aperient may be taken if this is found necessary. Worry, on the one hand, and stuffy rooms, on the other hand, should be as much as possible avoided, as these seem to be responsible for precipitating an attack. The disorder is evidently associated with certain general conditions which affect the composition of the blood, for women are notoriously more susceptible to attacks about the time of their periodic illnesses; and these attacks usually lessen, or completely disappear, when the child-bearing age is passed.

The treatment of the actual attack is little more satisfactory than the preventive treatment. At the very onset of the preliminary signs it is well to take a five-grain rhubarb pill or other simple aperient, and then immediately to lie down, covered up warmly, in a darkened room, from which all noise and conversation are excluded. A five-grain tablet of phenacetin or aspirin may be taken, though the effect of this varies much

with different individuals. No drug has yet been found to have any specific action on migraine, nor are we likely to discover such until we know more about the actual pathology of the blood and nervous system before and during the attacks.

MYALGIA, LUMBAGO, AND SCIATICA

These disabling, and often very painful, conditions are usually due to what is called fibrositis—that is, to a subacute inflammation of the membranous sheaths which envelop the fibres that make up our muscles and nerves. The tension resulting from this inflammation, either by pressure or by interference with normal reactivity, causes defensive and painful spasm, which normally is greatly increased if we attempt to move the part which is the seat of the trouble.

The symptoms are, unfortunately, known to most people—aching pain, intensified by all attempts at movement, being the outstanding manifestation. The possibility of successful treatment varies enormously. When the immediate cause of the trouble is over-use of local groups of muscles, a short period of rest often suffices to put things right again. The accumulation of waste products in the interstices of the bodily tissues is another not infrequent cause; in which case, a smart purge, followed by a course of gentle laxatives for two or three days, often proves effective. A good deal of temporary relief can often be afforded by running over the affected part with a hot flat-iron, the skin being protected by a substantial thickness of flannel, or a blanket. The application of a belladonna plaster sometimes gives relief; but a safe, and often very effective, curative practice consists in the taking of a warm bath or, better still, of a succession of warm baths at intervals of five or six hours. Where opportunity offers, the virtues of a Turkish bath may well be borne in mind. Apart from the simple aperients, the prescribing of drugs is best left to experts competent to discriminate between the various possible causes of the trouble and to determine how the inimical forces can best be countered.

NETTLERASH

Nettlerash, or urticaria, arises as a response to any one of a number of irritant poisons, external and internal. To any one previously unfamiliar with the condition, the sudden appearance of a rash, often covering the whole body, and accompanied by severe irritation, is rather alarming. As the word urticaria suggests, the characteristic of the eruption is a series of wheals or raised patches of skin, red near the circumference, and whitish towards the centre. The appearance and sensation are familiar to all who have ever been stung by stinging-

nettles. Contact of the skin with many other plants or, in some individuals, with particular fabrics, causes an urticarial eruption. Then, again, there are various blood diseases which occasionally manifest themselves in this way; intestinal worms, also, are recognized as occasional provocants. But probably the most frequent cause of nettle-rash is the absorption of various food products from the digestive canal. Different individuals are peculiarly sensitive to different articles of food; it may be eggs, or milk, or fish, or certain fruits.

Directly the rash appears it is well to take a calomel powder—one or two grains for a child, and three grains for an adult—followed by a dose of salts the next morning. Plenty of water should be drunk, and a twenty-four hours' fast from food is wise. The itching can generally be relieved to some extent by patting the skin with weak carbolic lotion of a strength one in sixty, or with calamine lotion. If the case does not quickly clear up a doctor should be consulted; as, occasionally, there are serious complications.

Nose-Bleeding

Epistaxis, or nose-bleeding, is usually a symptom of comparatively small importance. Occasionally, however, it may be the first indication of such serious general disorders as heightened blood-pressure, or kidney disease. Many people, when seized with nose-bleeding, make the mistake of hanging their head over a basin, thus increasing the flow of blood to the head and, consequently, to the nose. Assuming that a prompt stopping of the bleeding is desirable, the patient should sit in a chair, with the head thrown rather back, sniffing upwards at intervals, the cold air thus inhaled helping to coagulate the blood. Cloths wrung out of very cold water should be applied to the nose and to the back of the neck. Should these simple measures fail to arrest the bleeding, a little cotton-wool may be gently pushed up the nostril with the help of a blunt-ended match or similar object. If, in spite of these steps, the haemorrhage continues, it is wise to seek medical aid.

Sweating Feet

Some people suffer from a very distressing and unpleasant complaint called bromidosis. With only slight exertion their feet perspire in excess, and the perspiration is apt to possess a disagreeable odour.

Treatment is not always entirely effective; but much can be done to lessen the trouble and to add to personal comfort. Socks should be changed daily; it is best to wear moderately thick woollen ones, and to wash them before they are again worn. Every night the feet should be bathed for five minutes in warm water with which a little lysol (say a

teaspoonful to a couple of quarts) has been mixed. Every morning, dust the inside of the socks or stockings, and the whole surface of the feet, with the following powder: five ounces of starch powder, a pound of talc powder, and four drachms of salicylic acid.

Sore Throat

Sore throat is a common ailment that should not be too complacently regarded. Often this symptom is the first manifestation of really grave disorders, especially in children. Therefore, unless the soreness disappears in a day or so, medical advice should be obtained. As a first-aid measure, a saline aperient may be taken, and the throat may be gargled with a solution of carbolic acid, half an ounce to a pint of water. The sucking of chlorate of potash lozenges often affords relief.

Varicose Veins and Varicose Ulcers

Generally, this condition—which is one of over-distension of the walls of veins, accompanied by changes in those walls—is found in the legs; though the unpleasant disorder known as piles or haemorrhoids is also of the same nature. The actual cause of varicosity is not always clear. Any impediment to the return of blood to the heart through the veins is likely to lead to distention; and, naturally, the veins in the lowest part of the body and furthest from the heart are most likely to be the first sufferers. Habitual constipation, and pregnancy, by causing pressure on the big vessels into which the veins of the legs empty themselves, are not infrequent causes; though in the majority of cases no such obvious explanation can be found. Long hours of standing, as by shop assistants, when the return flow of the blood to the heart is not, as it normally is, promoted by the recurrent contraction of the muscles, is also frequently a contributory cause.

The essential thing to remember is that a varicose vein has faulty valves. In a healthy vein the blood flowing through it is constantly pressed forward by the contraction of the muscles around it towards the heart, and is prevented from flowing back by a series of valves. When these valves are ineffective the blood has great difficulty in rising against the force of gravity. The veins consequently become engorged, and the circulation through the adjacent tissues is unsatisfactory. These tissues, in consequence, are liable to break down and ulcerate. The nutrition of the skin in the neighbourhood of the affected veins also becomes disturbed, giving rise to discoloration and sometimes to severe itching—a kind of eczema often resulting. With or without ulceration a varicose vein is apt to burst; and the haemorrhage resulting

from such an accident is specially serious owing to the ineffectiveness of the valves, which allow the blood to flow freely towards the wound in both directions.

To take the most serious possibilities first. Let us consider the measures necessary to be taken if a varicose vein bursts. The patient should at once lie down and place under the leg pillows or cushions so as to raise it considerably above the general level of the body. Firm bands—bandages, or even handkerchiefs will serve—should then be tied round the limb both above and below the bleeding point. If there is still leakage, additional pressure may be applied to the bleeding point itself. The haemorrhage having been arrested, continued rest in a recumbent position should be maintained for a few days at least. An elastoplast bandage should then be applied, beginning at the root of the toes, and continuing across the ankles and up the leg until a point well above the limit of varicosity has been reached. Varicose ulcers may be treated by the application of elastoplast bandages much in the same way, these bandages being replaced about once weekly. They should be put on with reasonable firmness and careful evenness.

Every one with noticeable varicose veins should either wear elastic stockings or elastic bandages every day; or, more desirably, they should submit themselves to the doctor for injection treatment if he thinks that form of treatment advisable in their case. The injection treatment of varicose veins has proved remarkably successful, even where ulceration has occurred.

Warts

Warts are localized thicknesses of one layer of the skin, causing obvious projections on the surface, generally marked by noticeable increase of the horny cells which constitute its covering. It is generally believed that warts are both infectious by contact and capable of being inoculated from one person into another. All sorts of caustics and cauteries have been, and are, employed for the removal of these disfiguring little excrescences. Probably, however, the galvano-cautery and the electrolysis needle are the most useful agents. Carbonic snow is also often used with success. Common domestic applications are glacial acetic acid and fuming nitric acid, carefully applied with a wooden patch. As these substances are powerfully caustic, it is necessary to exercise care that no drop falls on the skin around the wart. Strangely, whole crops of warts sometimes disappear spontaneously in a night, even though they have existed for months or longer. It is not surprising, therefore, that many people believe that warts are capable of being charmed away by the use of incantations.

Photo by Herbert Williams

WOMAN AS QUADRUPED

Note the more rounded muscular masses, and the support given by the spine to the general structure in quadruped action

Writer's Cramp

This ailment often attacks people who spend many hours of their working day in making or copying legal and other documents in careful copper-plate writing, such as is employed by solicitors' clerks and the like. It seldom affects those who, although spending much of their time in writing, attack their task more boldly, making use of their shoulders and elbows, as well as of their hands, in the execution of their work. It is when the writing has become a craft, and much concentration on the precise and more delicate manipulation of the pen is involved, that this condition is likely to occur.

The first symptom is usually some degree of cramp or spasm in the thumb and forefinger after a period of work, so that it becomes difficult to guide the pen accurately; unintentional strokes are made, sometimes with such force that the pen is driven through the paper. If writing is persisted in, the condition nearly always gets steadily worse. The writing becomes jerky and illegible, and demands increasing effort. There is pain in the thumb, index finger, wrist, and forearm. The pen may drop from the fingers and, ultimately, can only be held by grasping it in some abnormal way. Curiously enough, during at any rate the early stages of the disease, it is only in the act of writing that there is loss of control or other discomfort. The sufferer from writer's cramp can perform almost any other task, using his hand with his usual ease and facility. This fact distinguishes this ailment from other forms of disorder, such as the various paralyses resulting from organic lesions in the brain or spinal cord. Also, it shows that the trouble is not really in the muscles or nerves of the hand, for these are quite ready to play their part in other activities.

Writer's cramp, therefore, may be said to be an 'occupation neurosis'; and is but a sort of specialized form of the condition spoken of as 'industrial fatigue.' That biological need for alternative occupation which marks our whole organism certainly characterizes the nerve-cells of our brain. A particular nerve-cell or group of nerve-cells, being called upon for too long a time, or too frequently, to direct an elaborate and 'unnatural' set of movements, becomes exhausted, and a stage of inefficiency and incapacity inevitably results.

The only treatment that has been found effective for this often distressing disease is exactly what one would expect. That treatment is, unfortunately, for many people, a very serious matter; consisting, as it does, in completely giving up writing of the kind which has been responsible for the trouble. If the first warnings have been disregarded, and an advanced stage of inco-ordination has been allowed to develop, writing of any kind will be out of the question for many months, possibly for years.

XXV—FIRST-AID IN EMERGENCIES

THE layman is usually wise to make an effort to understand the general principles on which his body is run, and to learn what he can of the conditions on which the maintenance of health depends. When things have actually gone wrong a degree of skill and knowledge is called for, such as can be acquired only by long and special training. In other words, the layman can usefully play an active part in preventing illness; but the treatment of illness is generally best left to the expert in such matters. In the lives of all of us, however, occasions frequently arise when disaster can be avoided only by the taking of prompt measures by the individual on the spot. If an important artery is severed, for example, it is futile to wait for the arrival of a doctor, taking no steps meanwhile to arrest the haemorrhage. People are knocked down in the middle of the road by passing motor cars, or fall unconscious in some crowded place. In such circumstances, we may not be in a position to determine the nature of the injury, or the cause of the collapse; but the invalid must, obviously, be moved to a place of safety; and it is important for us to know how he may be moved without further injury to him. Then, again, someone may by mistake have swallowed some poisonous substance; and his fate may easily depend on the immediate steps taken. Emergencies like these may confront us at any moment and in any place. In the following pages are summarized some of the more important principles to be observed in rendering first-aid treatment; and a few hints are given as to the actual steps to be taken before skilled aid can be obtained.

The foregoing paragraph roughly sums up the aims and objects that lie behind the principles of first-aid; and may help the student to appreciate its methods. But, apart from this, a real understanding can only be reached by a familiarity with the more essential points of the anatomy, physiology, and, to some extent, the pathology, involved in an accident and its treatment; and an attempt will be made to deal with these under their appropriate headings.

ON WOUNDS IN GENERAL

The whole surface of the body is covered by skin. This is a living tissue which, biologically, is recognized as being made up of several distinct layers. It has an ample blood-supply, the variability of which is well demonstrated in blushing and fainting. It has also a nerve-

supply that is responsible for our tactile impressions. The nerve-fibres do not reach the surface layers of the skin, but penetrate to roughly two-thirds of its thickness. Their terminations are extremely sensitive, and if, as the result of a burn, the superficial layers of skin are destroyed, and these nerve-ends are exposed, the shock of the burn is found to be much more severe than if the injury had destroyed a greater thickness of the superficial tissues. One of the most important functions of the cutaneous covering is its armour-plate action. The outermost layers of the skin are constantly being shed. But, previous to their shedding, they assume a hide-like texture, called 'cornification' (of which process a corn is an extreme example). This property of toughness serves a most useful purpose; offering an impenetrable barrier to the entry of organisms into the deeper tissues. In this connection it must also be understood that our environment is both formidable and potentially inimical, the air around us being full of myriads of germs, many species of which are really dangerous enemies if they enter through the damaged skin into the citadel of the human tissues. With this in mind, it can be easily seen that the harmful and even lethal potentialities possessed by almost any wound are very great. It is the realization of this that has led to the practice of preventive methods of first-aid, for the minimizing of the risk of wound infection.

Wounds themselves may be variously described. An incised wound is a cut with clean edges, made with a sharp instrument, such as a knife. These wounds are generally, though not always, superficial. The lack of damage to their edges, and their superficial extent, makes the prospect of straightforward healing better than with other types.

A lacerated wound shows edges that are bruised and injured. The dead tissues of this damaged area add considerably to the problem of satisfactory healing.

A punctured wound is a wound which has depth but little superficial extent. In this type of wound dirt is likely to be deposited, often at its deepest point; and infection with its attendant sequelae is very likely to supervene. Such a wound is highly dangerous, and needs treating with great caution. Especially should no amateur attempt be made to scoop out infected material that may have penetrated it, as such efforts may result in the deeper burying of the offending substance—often out of sight—when it may eventually be overlooked by the surgeon, with serious or even fatal consequences.

The immediate risks of all major wounds are those due to bleeding. it is always a possibility that an injury has severed the continuity of the major or minor blood-vessels in its path. For the control of the consequent haemorrhage, methods will be described subsequently. Infection of the wound may disclose itself at a later date. Contamination of the wound edges is likely to have been caused by the traumatizing agent

itself; the surrounding air may help to deposit bacteria on its surface; in some accidents gross dirt may have been conveyed to the wounded area by its contact with the roadway. The certainty, therefore, of latent infection must be constantly borne in mind. Any obvious contamination may be washed away or otherwise removed except, as has been said, when the wound is a punctured one. The application of soap and water to the skin edges and to the surrounding area is usually wise. Thorough cleansing considerably assists eventual repair, and should be carefully carried out. Occasionally, the skin round the wounded area is grimed and smeared with grease. In such a case, after cleansing has been performed, resort may be had to turpentine or alcohol for dissolving away the engrained dirt, care being taken to protect the wound itself against irritation by contact with the cleansing agent. When this macroscopic cleanliness has been secured, microscopic sterilization is to be aimed at. Disinfectants here provide a weapon against germ infection. Innumerable chemical disinfectants exist, possessing in various degrees the property of destroying germ life. Unfortunately these chemical bodies tend, *pari passu*, also to devitalize the living tissues with which they are brought in contact. Disinfectants are to be valued in so far as they possess a selective action on bacteria, with the least injury to tissues; while not only suitability of constituents, but an optimum dilution is equally to be aimed at. Among the everyday disinfectants, iodine—which may be applied undiluted—lysol, Dettol, Sanitas, and Condy's fluid (a teaspoonful to a pint of water), may be given precedence. Surgical spirit may, if available, be used, and is a potent sterilizer. Peroxide of hydrogen is also very effective. Time spent on efficient disinfection is never time wasted.

After cleansing, the wound needs protection against fresh contamination from the air. This is best secured by covering it with clean—preferably baked—linen, or, if available, sterilized gauze, and adding to this covering a thickness of cotton-wool; completing the dressing with a bandage, improvised, if need be.

Burns

A not unusual emergency is a call to deal with a person whose clothing is on fire. In the standing position there is a considerable likelihood that the flames may be fanned by the draught resulting from the blaze itself. The flames will spread much less readily if the person is laid flat on the ground. Pull off any clothing that admits of it, and wrap the subject in a jacket or, better still, roll him in a rug, blanket, or carpet, if such is available, so as to smother the flames. Once these are extinguished, dealing with the clothing becomes the immediate problem.

Cut away all those portions that are not adherent to the body surface; these should be left in position, to be soaked off later.

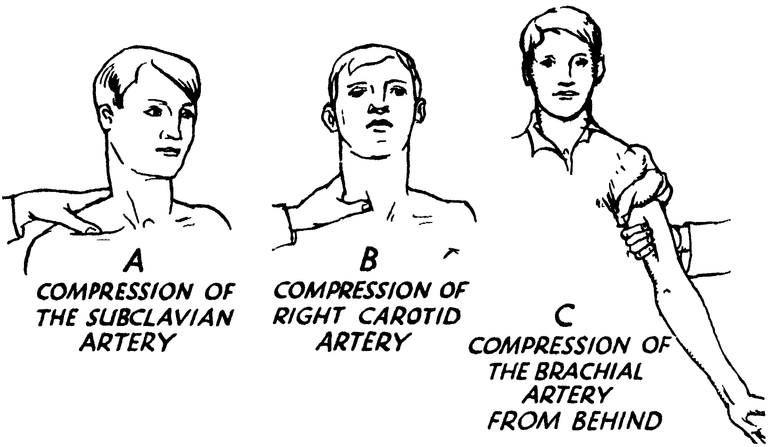
One of the most dangerous results of a severe burn is shock. The severity of this varies with the extent and the depth of the burning. Prompt treatment is essential. Very many methods of dealing with burned surface have, in turn, had a vogue. Carron oil was, at one time, liberally smeared on to the raw areas. Picric acid has been largely employed, not only because of its antiseptic properties, but because of its anodyne action. Both are unlikely to be household remedies, or to be very easily procurable in emergency, and both have their drawbacks. Oily substances collect and harbour dirt and germs, and as all burns are liable to infection, the risks should be minimized. A homely remedy that helps to assuage the pain is olive oil, but this is open to the same objection as other greasy dressings. Bicarbonate of soda is to be found in almost every home, and is very soothing. It is not open to any of the foregoing criticisms. In a strength of two teaspoonfuls to a pint of warm water, a solution of bicarbonate of soda may be applied as a dressing to any raw surface.

The modern treatment of burns consists in spraying the surfaces with tannic acid which, as its name implies, actually tans the skin. The 'hide' thus produced is Nature's best dressing, preventing infection, limiting the spread of the toxins produced in the wounded tissues, and thus lessening risk of shock; and at the same time promoting clean healing, with consequent avoidance of the contractural deformities which may follow extensive scarring. For success in the employment of this method, no previous greasy applications should have been used. Treatment of shock, dressing of the injured surfaces with bicarbonate of soda—as a preliminary to tannic acid spraying—and keeping them from exposure to the air, are all within the province of first-aid.

The Arrest of Bleeding

The vascular system of the body, with its network of arteries, veins, and capillaries, is fully described elsewhere in this book. It is enough to state here, by way of recapitulation, that impetus is provided to the circulating blood by the contractions of the heart-muscle acting as a pump; that the blood circulates through channels of varying calibre; and that these channels are continuous. The large arteries leading from the heart, carrying the red re-aerated blood, divide and subdivide till the tiny capillary size is reached; these reunite to form the veins which carry back the darker soiled blood from the tissues to the heart, whence it flows to the lungs, and is returned again to the heart for redistribution. The constant movement of the blood demands a momentum which varies in the different sets of vessels. In the arteries

considerable force is required to urge the blood onwards; when the capillaries are reached, this momentum is largely expended, and in the veins the pace is very slow, the blood being moved along chiefly by suction from the heart, aided by squeezing movements of the surrounding muscular tissues. Hence it is that venous pressure is trifling in comparison with arterial, and that venous bleeding is so much easier of control. Arteries and veins steadily increase in size as they near the heart; capillaries are minute, and practically ubiquitous in their

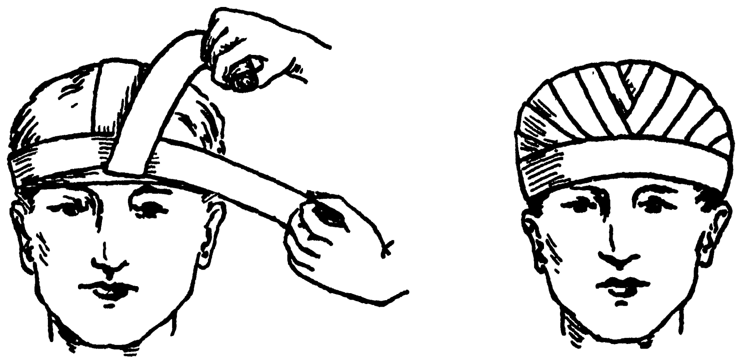


distribution. A cut must, of necessity, enter some portion of the vascular system, and bleeding must result.

The arrest of bleeding, or 'haemostasis,' is a vital matter; for without it any accidental cut or graze, however slight, would certainly lead to death. The natural mechanism which, in normal persons, brings about such an arrest is in certain individuals ineffective or absent; and with such people, colloquially known as bleeders, trivial cuts and bruises may become serious and even fatal. The process by which bleeding is checked in its slighter and early stages is by clotting or congealing of the blood; which, like solder, effectually mends the leak. Nature has provided that if the blood comes in contact with a foreign substance —in which definition is included the lacerated edges of a wound—it ceases to be fluid, and coagulates, much as milk does on the addition of rennet. This solidified blood acts as a seal to the severed blood-vessels, and checks the escape. In its early stages such a repair is flimsy; and if the pressure of the escaping blood is great the clots are rapidly expelled and cease to be an effective blockage. It is for this reason that limbs are raised and patients are laid flat in an attempt to reduce the blood-pressure at the bleeding spot. Clotting is further

assisted by pressure on the wound, which, incidentally, causes a considerable fall in blood-pressure in that area.

The application of pressure is, therefore, the first step in the control of bleeding, and should invariably be employed except where broken bones or broken glass are within the field of compression. Occasionally it happens that a large vessel has been cut across, and these simple measures prove ineffective. In such a case a main branch of the vessel will call for closure by the fingers. In the case of a cut artery this closure should be to the proximal side of the wound; in the



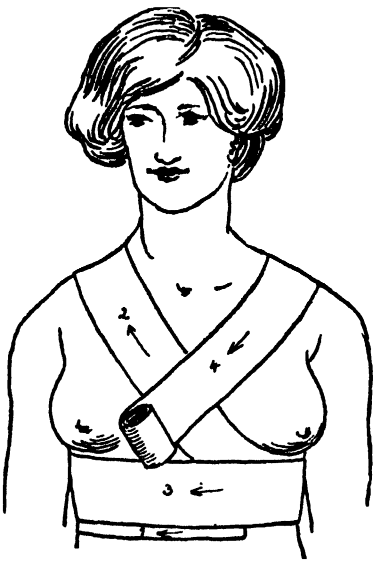
CAPELINE BANDAGE. (Two roller bandages are used.)

case of a vein, on the distal. (By 'proximal' is meant, nearer to the heart; by 'distal,' further from it.) The two forms of bleeding can be easily distinguished, as blood escapes from an artery in gushes, corresponding with the impulses from the heart; whilst from a vein it wells out in a continuous flow. To guide the operator in the control of such haemorrhages, a knowledge of the main branches of the vascular system is needed.

Arising from the heart is the thoracic aorta; which gives off, first, the innominate artery, then the left common carotid and the left subclavian. The innominate artery later divides into the right common carotid and the right subclavian. The thoracic aorta continues as the abdominal aorta; which, again, breaks up into the right and left common iliac arteries at about the level of the navel. These shortly subdivide into the external and internal iliacs, the latter being continued into the legs as the femoral arteries.

In order effectively to compress an artery it must be pressed by the finger or other object against a bone; so that a convenient place must be found at which the artery and a bone come close together. The common carotid extends into the neck, and is best compressed at the level of the lower limit of the Adam's apple, a little to one side of this

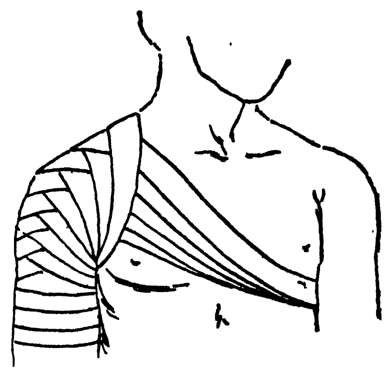
structure. Compression here, however, has its dangers, and should not be resorted to unless other methods have proved ineffective. The artery ends in the external and internal carotids at the upper border of the apple.



ROLLER BANDAGE FOR BREAST

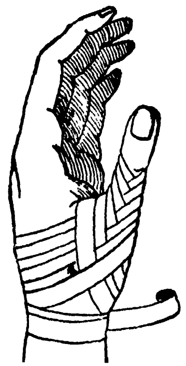
The internal carotid does not concern us further; but certain branches of the external carotid call for mention. The facial branch of the external carotid can be felt pulsating an inch in front of the angle of the lower jaw, along its lower border; and this may be taken as a suitable pressure point in checking bleeding from the lower zones of the face. The temporal artery, another branch of the external carotid, is compressed a finger's breadth in front of the opening of the ear, and will control bleeding from the forehead and frontal areas of the scalp. The occipital artery, which arises from an entirely different system, and supplies the posterior portion of the scalp, can best be brought under control by running a horizontally-placed finger upwards along the back of the neck, and bringing it to rest forcibly against the first horizontal bone that it meets on reaching the skull.

The subclavian artery supplies the arm. The main branch is closable by firm pressure behind the middle of the collar-bone, with the point of the shoulder well depressed. The subclavian proceeds into the arm as the axillary artery (the artery of the armpit), but is difficult to compress against the head of the humerus—the bone of the upper arm. The axillary becomes the brachial artery, which is best compressed along the inner side of the middle of the upper arm, directly outwards against the humerus. At the bend of the elbow, the brachial becomes the radial and ulnar arteries. Compression here is difficult, but may be effected by wedging a ball of material into the 'hinge,' and forcibly flexing the

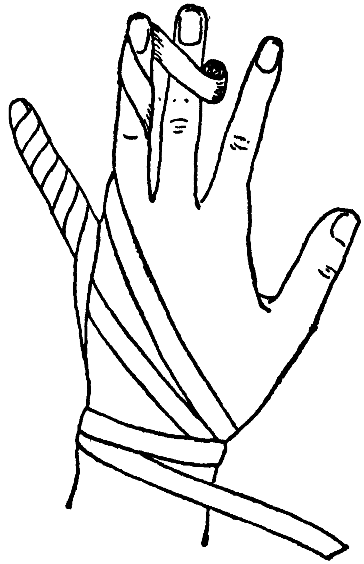


SPICA BANDAGE FOR SHOULDER

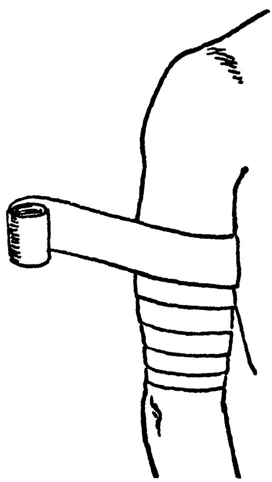
forearm on to the upper arm, holding it in this position. The radial is the artery of the pulse. The radial and ulnar form an arch in the



SPICA BANDAGE
FOR THUMB



FINGER BANDAGE



SPIRAL BANDAGE FOR ARM

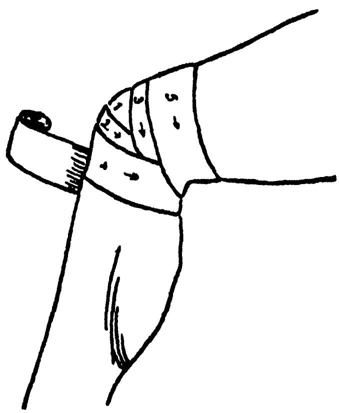


FIGURE-OF-EIGHT SPICA BANDAGE
FOR KNEE

palm, and bleeding from this latter, if not checked by proximal pressure on the sites indicated earlier, may be dealt with by forcibly shutting down the hand on to a wide, thick roll of gauze, and then firmly bandaging the whole.

In the leg the femoral artery in its upper reaches takes the line of the front crease in a man's trousers; and it is best compressed in the groin. It is also compressible in the ham, in the line of the back crease of the trousers, the artery being known here as the popliteal artery. The central and posterior tibial are terminal branches, and are compressible respectively in front of and behind the inner projection of the ankle.

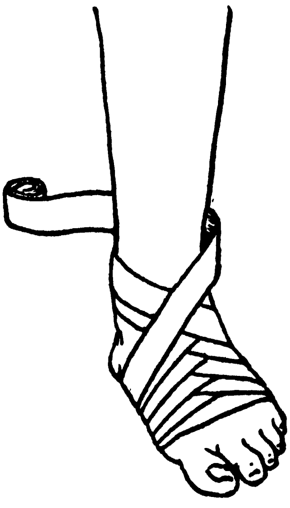
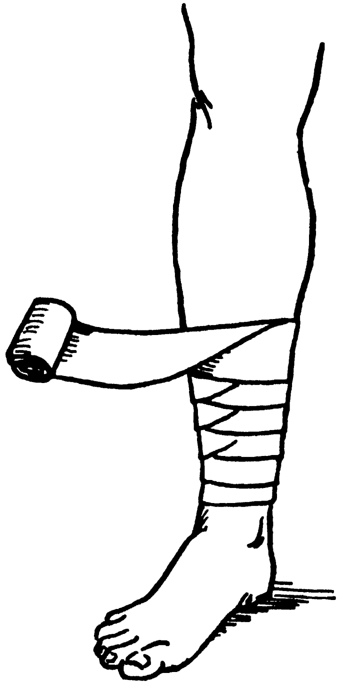


FIGURE-OF-EIGHT BANDAGE FOR FOOT



REVERSED BANDAGE FOR LEG

In dealing with any severe haemorrhage, lay the patient down; elevate the limb; avoid stimulants, which increase the blood-pressure; and apply local compression except where broken bones or broken glass are known to lie in the damaged area.

If these methods fail, bearing in mind the course of the blood-vessels, seek out the nearest proximal pressure point, and compress it. Compression may be applied by finger or by tourniquet. Finger pressure is best, but it cannot be kept up for long periods. Tourniquet pressure is more lasting. It must not, however, be continued for more than half an hour, but should be alternated with finger control. Tourniquets are usually made of rubber, but they may be improvised from linen or handkerchiefs folded into a narrow band, with a knot in its length so

By courtesy of Kodak Ltd.

FRACTURED SPINE (ACCIDENT)

placed as to lie over the vessel at the point where pressure is desired. The tourniquet should be applied just so tightly that all bleeding ceases; insufficient tightening occasionally increases the haemorrhage. By placing a pencil or stick in the loop of the improvised tourniquet, and twisting it, considerable compression may be arrived at.

In all cases of severe haemorrhage the patient should, as soon as possible, be transferred to a hospital, whilst in slighter cases a doctor should be called in. Copious drinks of water help to satiate the extreme thirst a severe haemorrhage induces, and these may quite safely be given.

Bleeding from the scalp can be very intractable. If pressure on the temporal and occipital arteries does not check it, a circular tourniquet may be applied around the head, proximal to the bleeding point. Local pressure may be attempted, provided there is no fracture of the skull.

Bleeding from varicose veins is peculiar, inasmuch as the bleeding is almost equally pronounced from distal and proximal sides. The bleeding is venous—that is to say, it is darker than the bright red arterial blood—and it wells up from the depth of the opening instead of spurting, as it does from an artery. It is best controlled by both proximal and distal tourniquet compression, together with firm local pressure.

Accidents to Bones and Joints

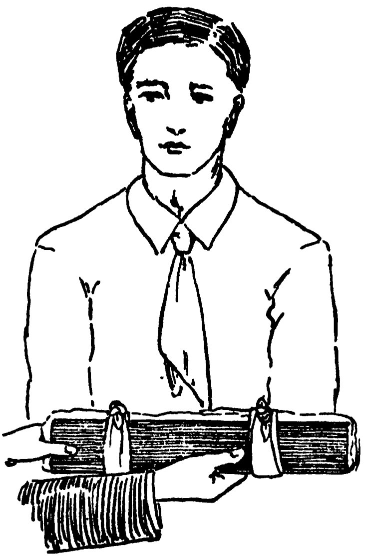
With the bony framework of the body may be included the musculature that holds it together, and by its contraction brings about the movements necessary for locomotion and change of posture. The bones of the body are arranged on a primitive and simple plan. There is a central axis, extending from the head to the tail, composed of the various vertebrae, thirty-three in number. Around this are constructed two bony girdles, almost at its limits; to which girdles are, in their turn, attached the limb appendages. The upper girdle, constituted by the shoulder-blade and the collar-bones, is called the pectoral girdle; whilst the lower, consisting of the pelvic bones, is known as the pelvic girdle. To the former the arms are attached; to the latter the legs.

The structure of these two sets of appendages is on a similar or comparable plan. The arm has a single proximal bone, the humerus, and two more distal bones, side by side, the radius (on the same side as the thumb) and the ulna. At the end of these is a set of bones of the wrist, called the carpal bones; and finally, the metacarpals and phalanges which make up the hand and fingers respectively.

In the leg the corresponding forms are the femur, then, below the knee, the tibia and fibula, then the tarsals, metatarsals, and phalanges. At the upper end of the skeletal axis is the head.

The structure of the joints is dealt with elsewhere, and the details

need not here concern us. The movements of the bones of which they form the hinges are brought about by contractions of the muscles inserted about these hinges, arranged so as to form a series of levers, with their long and short arms placed to the greatest mechanical advantage. A fracture, by destroying the long or the short arm of the lever, interferes with the mechanical working of the joint, and immobilizes the affected limb. A dislocation, by jamming the hinge itself, completely inhibits all movement until the normal state of things is restored.



FRACTURE OF FORE-ARM—FIRST-AID TREATMENT

Skeletal injury may consist either of a dislocation or of a fracture. In a dislocation the injury will naturally lie at the extreme end of the affected bones. Fractures, on the other hand, by involving the bone at some spot in its length, are often situated some distance away from its extremity. In the rough-and-ready diagnosis of such injuries, this fact may be of use.

Sprains are injuries occurring at the joints, where the damage has been insufficient to produce a real displacement of the bony surfaces, but has, by the temporary wrenching of them apart, caused a laceration of the ligaments holding them in apposition. The significance of these injuries lies in the fact that, though the immediate damage is not of great moment, the weakening of the ligaments calls for a prolonged period of rest, or their repair is inefficient and their primitive tautness is never quite restored. Sprains of the ankle, unless properly and sufficiently rested, often play a part in the causation of flat-foot.

Shortly after damage to a joint, local bruising reveals itself. In addition, tenderness is felt on the site of the rupture of the ligament; whilst all movements are painful and limited in their extent. A figure-of-eight bandage has a comforting and a supporting effect, and helps to check effusion into the joint-space. Cold water frequently applied so as to keep the bandage moist helps; or Goulard's lotion in half strength may be substituted. Complete rest is called for for a period suitable to the extent of the damage, and rest should be most prolonged in the case of ankle injuries.

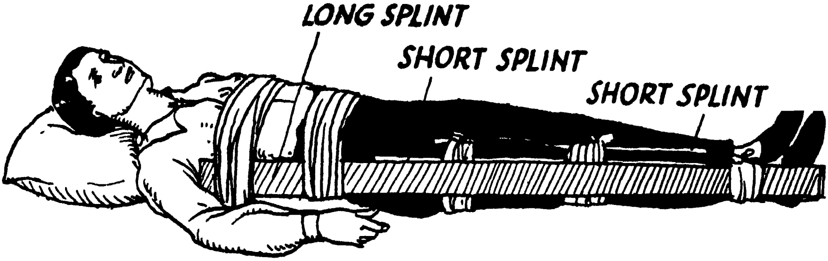
Above all, it should be borne in mind that slight fractures of the tips of bones—again especially about the ankle—are frequently undiagnosed

By courtesy of Kodak Ltd.

TWO VIEWS OF A FRACTURE OF LEFT FOREARM BY MOTOR ACCIDENT

when occurring in conjunction with a severe sprain. Equally misleading may be the sprained wrist, where, in addition to the sprain, a small carpel bone is sometimes fractured and the injury overlooked. Both these fractures need careful surgical supervision, or permanent stiffness of the joint involved is likely to follow.

All dislocations involve muscular and ligamental sprain. In addition, the opposed joint surfaces are definitely put out of apposition. This accident causes a complete immobilization of the joint. The surrounding muscles are on the stretch, partly because of the new position, partly because of a protective spasm which Nature imposes on them.



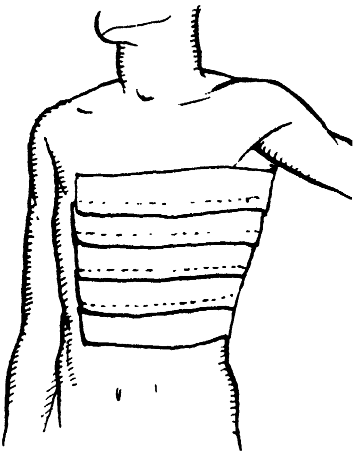
SPLINT FOR FRACTURED THIGH

This spasm of the muscles is to some extent the cause of the severe pain that differentiates a dislocation from a fracture. The great pain and immobility, and alteration in the appearance of the limb at the site of the displacement, together with the history of the injury, help in the recognition of the condition.

As a reduction of the displacement to the normal calls for skilled anatomical knowledge, and an appreciation of the route to be retraversed by the displaced part, it follows that it is unwise for any one but a competent surgeon to attempt it. It should be remembered that any injudicious force exerted in such an attempt may add to the original injury; as muscles may be torn, nerves stretched, and the bones themselves even fractured by incorrect leverage. The best first-aid treatment consists in supporting the affected part in that position which is most comfortable to the patient. For a dislocated shoulder—the most common type of dislocation—a long arm-sling supporting the elbow is all that at first is called for. Dislocated legs can, of course, support no weight. Immediate surgical aid should be sought, and the patient prepared for transport. It is as well to realize that the great pain experienced, together with the original trauma, often cause a considerable degree of shock to the patient.

Fractures are the result of violence; and, whereas, as has been said, a dislocation always occurs at a joint, fracture may happen at any point along the length of a bone, often at some distance from the joint.

Deformation of the limb may be recognizable, and is, indeed, often marked. The limb can make no voluntary movement, and if passive movement is imparted to it—a most unwise method of diagnosis—crepitus, or a fine grating, due to the rubbing together of the ends of the broken bone, will occur, at the site of the fracture. Though the patient is in pain, this pain is never as intense as in the case of a dislocation.



STRAPPING OF BROKEN RIBS

If the damage is entirely limited to bone, a simple fracture results. Should other tissues be involved, the fracture is regarded as complicated. The most serious complication is that in which the tip of the bone has pierced the skin, or in which there is a wound communicating directly or indirectly from the surface of the body to the seat of fracture. Such cases are known as compound fractures. The jagged ends of bone may tear across adjacent blood-vessels, leading to haemorrhage; or may perforate nerve-fibres in their neighbourhood, causing various degrees of paralysis. Such complications as these may have been directly caused by the original accident; but it must be recognized that injudicious 'help,' or unwise diagnostic testing by amateurs, may add very greatly to the primary damage. Bearing these possibilities in mind, every care should be taken to avoid their occurrence.

The grave importance of the compound fracture, as compared with the simple and uncomplicated, lies in the danger of infection. Of all body-tissue, bone-marrow is easily the most defenceless. Once it is contaminated by contact with germ-laden air, the risk of fatal infection is greatly increased. On account of this potential danger it is essential that a simple fracture be handled as little as may be, so as to prevent the occurrence of this dangerous complication of the injury. If a compound fracture is encountered scrupulous attention must be paid to the sterilization of the wound surfaces, and to their complete isolation from the outer air.

Fractures are grouped, according to their type of bone injury, as oblique, transverse, spiral, comminuted, and green-stick. The first three names refer to the shape of the line of the break; a comminuted fracture is one in which, at the point of the break, the fragments of bone are multitudinous and even microscopic; whilst green-stick fracturing usually occurs in the bones of children and young persons, and the

By courtesy of Kodak Ltd.

FRACTURE OF RIGHT FIBULA AND TIBIA

damage, as its name implies, may be compared with the breaking of a green twig or bough. In these latter fractures some portion of the bone still remains in continuity, though the greater part of it may have snapped.

The aim of first-aid, in all these cases, is the reduction of the deformity by the re-apposition of the ends of the bone, the support of the limb, and the preparation of the patient for transport. Stimulants may be needed to lessen the risk of attendant shock. If the lower limb has been involved, an inspection should first be made to exclude the possibility of a compound injury. Superficial and non-penetrating wounds, should wounds exist, will need treatment and cleansing as instructed above. If deformity is marked, gentle traction should be exerted on the distal fragment until the limb is straight. It should be maintained in its corrected position, and splints applied. The general rules for the application of splints to an injured part may best be summarized in series.

(1) Wherever possible attempt to immobilize the joint above and the joint below the fracture.

(2) Apply the splints to the outer and the inner sides of the limb. The outer splint should invariably be the longer.

(3) Never bandage a limb too tightly, or allow the splint to press unduly on the flexures, such as the elbow, armpit, or bend of knee.

(4) Parts which may become painful on continued pressure, such as the ankle and heel, need isolation from the splint by the intervention of suitable padding.

A difficult situation sometimes arises when a fracture is associated with severe haemorrhage. In a previous section it was directed that such bleeding should be checked by pressure over the wounded area; but exception must, of course, be made where such pressure might be transmitted to underlying fragments of bone. In so doing, soft tissues intervening would be further lacerated, and greater damage would be done. Digital or tourniquet compression of the artery supplying the area is alone admissible, and this should be attempted before proceeding to treatment of the fracture itself.

Each and every fracture calls for a particular type of bandaging and splinting. They are, however, too varied to come within our present scope. Fractures of the skull and of the spine need separate description. The former will be dealt with in a later section.

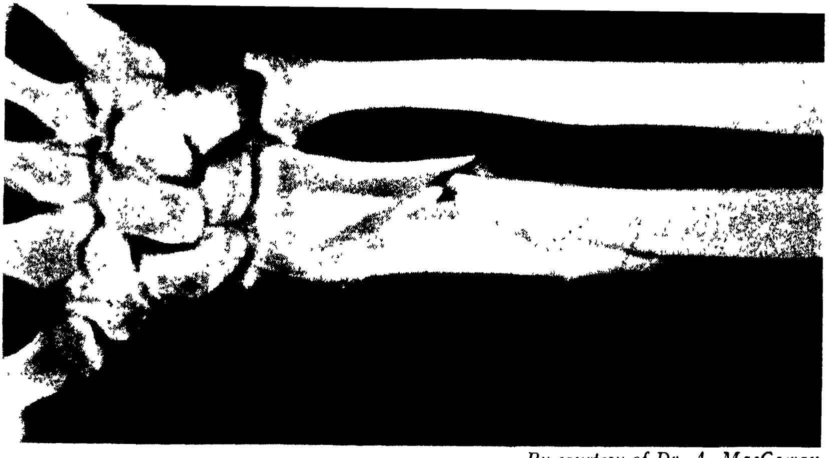
In the upper part of the neck, fracture occurs as a consequence of hanging, judicial or other. In the lower part, direct injury—though this is rare—as by diving into shallow water, may cause fracture. Death may and usually does occur immediately or in a few days. Motor

crashes, hunting-field accidents, and the striking of the head when passing under a low-set bridge are among the commoner causes of fractures of the spine within the trunk. Unconsciousness may follow the accident, and shock is very marked. If the upper dorsal area is involved, the patient may be completely immobile from paralysis. This paralysis, however, is variable, and if the injury occurs in the lower trunk the arms may escape. Should the injured person be conscious a great deal of pain will be felt at the site of the lesion, and the normal course of respiration and of micturition, amongst other things, will be considerably disturbed. The duty of the assistant here is to prepare the patient for transport, and as far as possible to immobilize the spine; but in so doing he must be careful to avoid doing anything that might aggravate the mischief. If a sheet, a tarpaulin, or a greatcoat is available, this should be introduced under the body of the subject by a sawing movement, as he lies flat on his back. By fixing the long edges at each side to two poles, or by lifting with four helpers on each side, a comparatively stiff and straight support to the spine may be assured, and the patient carried to some form of stretcher—a five-barred gate or hurdle, or a board of suitable dimensions. Shock, which is likely to be considerable, must not be overlooked. Removal to a hospital or nursing home is imperative.

Fracture of a rib or ribs is an accident common in the gymnasium and the playing-field and is one of the most frequent accidents of old people. A characteristic sign is a cutting pain in the chest wall at the site of the injury, on deep breathing; whilst pressure on the involved rib at some distance from the fracture elicits tenderness in the area of the break. Treatment consists in keeping the injured side still by strappings of adhesive plaster applied, with the chest fully deflated. In applying the strapping, each strip must overlap the previous one, and each should be long enough to extend to some portion of the chest wall on the sound side as well as on the injured one.

Poisons and their Immediate Treatment

Whenever any one is suspected of having, accidentally or intentionally, swallowed anything of a poisonous nature, a doctor should be sent for instantly. There are, however, certain measures which should be taken before the doctor arrives; and these measures vary with the nature of the poison swallowed. Poisons act on the body in different ways, and the appropriate treatment, both immediate and subsequent, differs accordingly. The commoner poisons are conveniently classed in groups.



By courtesy of Dr. A. MacGowan

FRACTURED RADIUS BONE OF FOREARM

By courtesy of Dr A. MacGowan

THE FRACTURED ARM

CORROSIVE POISONS.

Among these are the strong acids, such as sulphuric acid or oil of vitriol, oxalic acid, nitric acid, hydrochloric acid or spirits of salts, and carbolic acid; the powerful alkalis, such as caustic soda, caustic potash, and ammonia; and various corrosive salts, such as nitrate of silver, chloride of zinc, and perchloride of mercury or corrosive sublimate.

The outstanding immediate symptoms of corrosive poisoning are burning pain in the mouth, throat, and stomach, usually accompanied by vomiting and often by diarrhoea; there is a general feeling of constriction in the throat, with marked signs of collapse. The lips are often excoriated.

In the way of first-aid treatment the chief instruction is a negative one. Do not give an emetic. If the poison is known to be one of the mineral acids (sulphuric, nitric, or hydrochloric), give warm water with chalk, or whiting, or magnesia, or even wall plaster, powdered and stirred up in it. Follow this with milk and egg, or olive oil. Keep the body warm with blankets and hot-water bottles. If carbolic acid has been taken give, instead of the lime or magnesia, half an ounce of Epsom salts with half a pint of water, followed by copious draughts of milk or olive oil. Treat oxalic acid poisoning much as poisoning by the mineral acids—chalk or lime being an antidote. If the poison is one of the caustic alkalis, give diluted vinegar or lemon juice, or tartaric acid in solution, followed, as before, with milk or olive oil.

IRRITANT POISONS.

In this group are included arsenic, lead, turpentine, phosphorus, and most of the food poisons—including mushrooms. Arsenic is contained in fly-papers, various vermin killers, many colouring matters, and weed killers, as well as in several medical preparations. Phosphorus is a common ingredient of rat poisons and of match heads.

Most of the irritant poisons give rise to dryness of the throat, pain in the stomach, thirst, vomiting, faintness, and general shock. Emetics should immediately be given; useful ones commonly available consisting of a dessertspoonful of mustard in a tumbler of warm water, or two tablespoonfuls of table salt in a tumbler of warm water. The throat may be tickled with a feather, or with the finger, copious draughts of warm water having first been given. Though they are not likely to be available in the average household, one or two of the principal antidotes may be named; but antidotes should not be given until after the emetics have done their work. In the case of arsenic poisoning, a quarter of an ounce of chloride of iron, mixed with washing-soda and water, may be given. In the case of phosphorus poisoning, a teaspoonful

of turpentine in an ounce of water may be given every quarter of an hour or so, for three-quarters of an hour. Oily or fatty liquids should not be given in phosphorus poisoning.

NARCOTIC AND OTHER POISONS.

Prominent among these are opium and morphia preparations, belladonna (deadly nightshade), prussic acid, chloral, hemlock, and strychnine. The symptoms vary much. Strychnine poisoning is characterized by convulsive movements of the limbs, and often of all the muscles of the body, except the jaw muscles. There is a feeling of suffocation. Opium or morphia poisoning is characterized by progressive drowsiness and loss of sensibility; the skin is cold, and the pupils are markedly contracted; the pulse is feeble, and the muscles relaxed. Belladonna poisoning, sometimes consequent on eating the berries of the deadly nightshade, is marked by a dryness of the throat and mouth, by slow breathing, quick pulse, and often delirium; the pupils of the eyes are dilated. Prussic acid, which is one of the deadliest and most quickly acting of poisons, first manifests itself by giddiness, loss of muscular power, insensibility, and gasping for breath; also, there is quick and profound collapse.

Each of these poisons calls for special treatment; but there are certain immediate measures to be taken in all cases. Emetics must be given at once. The face may be dabbed with cold water, and a bottle of ammonia repeatedly held to the nostrils. The body should be kept warm. In belladonna poisoning, hot coffee may be given; in morphia or opium poisoning, the patient should be kept awake and, if it is available, ten grains of permanganate of potash should be given in a teacupful of water. In chloral or hemlock poisoning, artificial respiration should be employed if necessary. In strychnine poisoning, half a teaspoonful of tannin or tannic acid may be given in half a teacupful of water.

Poisoning by coal-gas has been an increasingly common method of suicide in recent years. The circumstances in which the victim is found usually give sufficient indication of the nature of the trouble. The pulse and breathing are generally rapid, and the face is commonly livid. There may be giddiness, ringing in the ears, and convulsions. Fresh air is the first essential. Artificial respiration (see page 684) should at once be resorted to, and warmth should be retained in the body by the use of blankets and hot-water bottles.

Suffocation and Drowning

Aeration of the blood is a prime necessity of life. This process comprises the absorption of oxygen from the air into the blood, and the giving up of carbon dioxide and other gaseous products of metabolism by the blood into the outer air. Deficient aeration helps to produce the headache and drowsiness experienced in stuffy, overcrowded rooms. Absolute deficiency is incompatible with life.

Amongst the physiological processes which contribute to the maintenance of the aeration of the blood-stream, respiration is of the highest importance. For the conduct of normal respiration three sets of factors are essential: there must be air to breathe; there must be a clear passage-way to breathe through; the respiratory movements must be maintained and controlled by vital centres in the brain, and free play must be allowed to those movements.

Interference with the first of these necessities occurs in drowning and in asphyxiation by smoke or by gases. Many things may interfere with the air-way itself. The orifices may be blocked, as in smothering or, commonly, in 'overlaying.' The latter is a not unusual cause of suffocation in infants, often occurring when a tired nursing mother takes her baby into her own bed at night to feed it, and falls asleep. Choking by food 'going down the wrong way,' or by the tongue falling back in deep unconsciousness and sealing the windpipe, or by constriction by a band applied tightly round the neck as in strangling, all must be considered under this heading.

Occasionally, the movements of the chest wall are obstructed by mechanical factors, as when a labourer is buried by a fall of earth, and may die of asphyxiation even with his head in the open air.

The paralysis that overtakes the respiratory centres may be recovered from if prompt temporary aeration is secured by artificially provoked respiration. Should help not be at hand, the lack of aeration will paralyse the cardiac centres also. When this has occurred, the patient is out of reach of any help that mechanical breathing can offer. It is this that sets a time limit to the period during which attempts at resuscitation have any chance of success.

An appreciation of the foregoing facts serves as a foundation for the rational treatment of specific types of asphyxiation. To recapitulate: four things are needed; air to breathe, a clear air-way, freedom for the respiratory movements, and a reawakened respiratory centre.

In order to secure a clear air-way, the tongue must in every case be pulled forward. In the unconsciousness of asphyxiation it may easily fall back and block the air-passage. In cases of smothering, the clothing should be loosened, especially about the neck, and the tongue brought forward. If breathing has ceased, artificial respiration should be

promptly begun. In suffocation by smoke or gas, the patient should be at once removed into the open air, and artificial respiration (see below) applied.

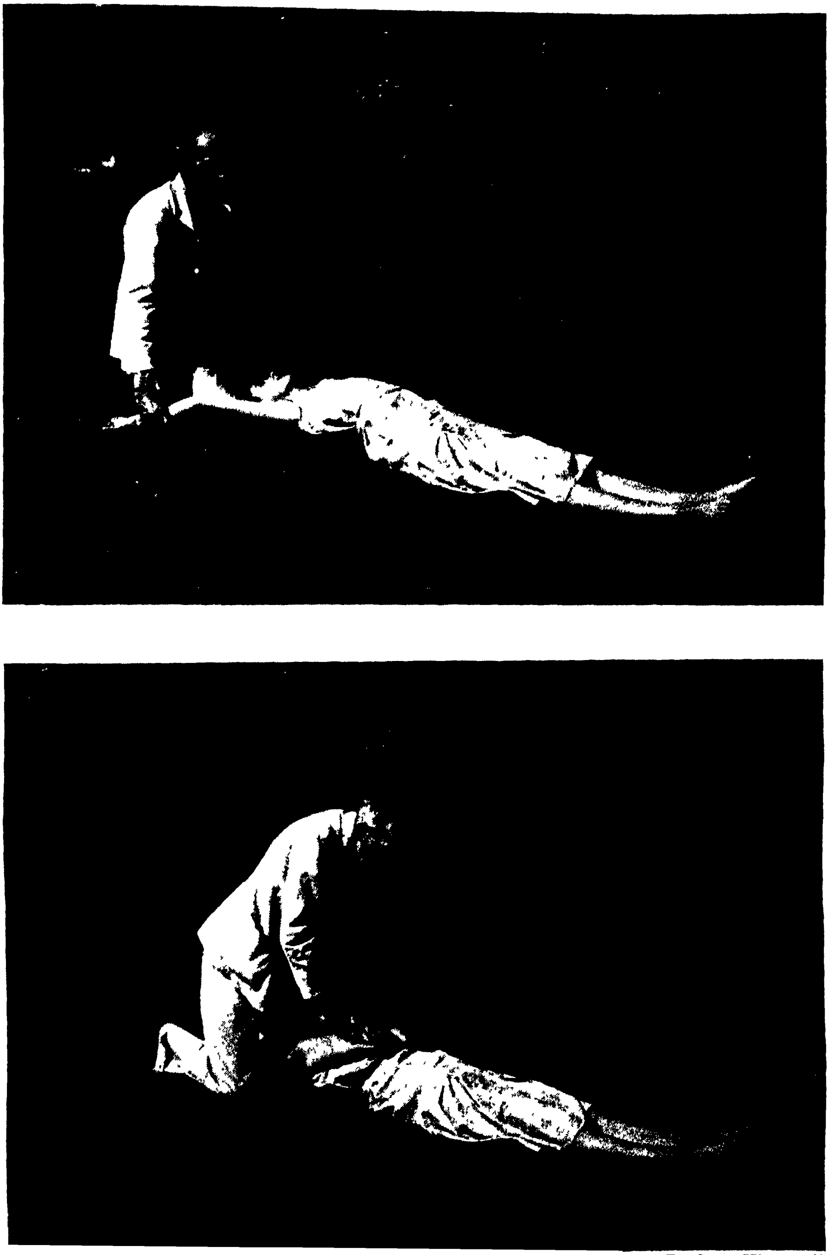
On finding a person hanging, it is at once imperative to take the weight off the rope and to remove the constriction round the neck. The strangling effect of the noose is in proportion to the weight suspended from it. Every effort should be made to cut the rope; but, if this is not immediately successful, the body should be supported, so as to remove the tension. Do this instantly and remove the noose, even before seeking aid. Then, when the body has been lowered to the ground, proceed with artificial respiration.

When choking results from swallowed food, encourage coughing, which may dislodge it. Sometimes vomiting, artificially provoked, may be effective. If the patient is a child, holding it upside down may serve to expel the fragment. Should all else fail, attempts may be made to hook the offending mass out of the back of the throat by the finger.

Where asphyxiation is due to burial under collapsed material, the patient should, of course, be extricated as soon as possible. He should then be dealt with as in other cases of suffocation. In such circumstances, however, the possibility—even probability—of a fractured rib or ribs must always be borne in mind, and a method of artificial respiration chosen which will not aggravate such an injury.

Artificial Respiration

In dealing with the apparently drowned, or with the partially asphyxiated from any cause, the patient should be placed face downwards, the face turned to the left, with the right arm bent, the elbow under the head. The mouth should be thoroughly cleared of seaweed or other obstructing material, and the tongue pulled forward—if the Schäfer method of artificial respiration is the one employed, it will remain thus. All clothing around the neck and chest should be loosened. Straddle the body, kneeling on either side of the hips, and facing the head. Place the hands, palms undermost, on the lower chest wall, their lower, or little-finger, edges in line with the lower ribs. If the hands are placed too high, they will merely press on the shoulder-blades and do no good; if placed below the thorax, the pressure is not exerted on the lungs. Now, with the arms rigidly extended, transfer the weight to the palms, keeping up the pressure for a time long enough to repeat: 'one thousand, two thousand, three thousand.' Then swing backwards, relaxing the pressure, but keeping the arms still rigid as before, for long enough to say 'four thousand, five thousand.' These movements should be kept up until automatic normal respiration has been



: by *Barbara Wagstaff*

ARTIFICIAL RESPIRATION
Sylvester's Method

established. Artificial respiration should be persisted in until all hope of recovery has passed; for life has been restored even after so long a time as two hours, the operators, in such a case, working in relays. The patient should be kept warm with rugs, coats, and hot-water bottles.

Another method of performing artificial respiration is known as Sylvester's. The patient, having first been quickly turned face downward, so as to empty the mouth of water or other material that may be blocking the air-passage, should be rolled over on to his back, a folded rug or coat being placed under his shoulders, so that the head may hang somewhat backwards. The operator then kneels, with one knee on either side of the patient's head, folds the patient's forearms on the upper arms, and grasps them firmly near the elbow. He then draws the arms steadily upwards and outwards as far and as high as they will go, holds them there for a couple of seconds, and then brings them down steadily slightly to the front of the sides of the chest wall, and presses firmly on the chest for a further period of about two seconds or a little less. These procedures should be continued with regularity, and without jerkiness, about fifteen or sixteen times a minute, until the patient begins to breathe. In the absence of a doctor, it is wise to persist with artificial respiration, even for an hour or more, though the patient may show no sign of life meanwhile.

More modern methods of resuscitation employ carbon dioxide inhalations to stimulate the respiratory centres in the brain, and for this purpose apparatus is often kept in the beach huts maintained by Red Cross societies.

In cases where fracture of the ribs complicates asphyxiation, Schäfer's method cannot be used, nor can any other which depends on rhythmic pressure over the ribs. Another method of tongue withdrawal must in such an emergency be substituted. In this, the tongue is firmly grasped in the fingers, drawn out, and then allowed to fall back, counting to define the interval, as before. This method is far less effective than either of the other two described.

Unconsciousness

Deep unconsciousness may simulate death; but is usually recognizable by the presence of certain vital phenomena such as breathing and the persistence of the heart-beat. In slighter unconsciousness, a dazed state is usual. In deep unconsciousness, the patient lies motionless and the whites of the eyes are insensitive to touch. In very deep coma, pressure can be applied even to the supra-orbital nerve, which is situated in the inner and under angle of the eyebrow about a finger's breadth from the nose, without causing any apparent discomfort.

Feigned unconsciousness is common in hysteria, but will not resist these tests.

Unconsciousness may follow excessive drinking, epileptic fits, injury to the skull or spine, or the taking of opium or other narcotic poisons, and occurs in certain pathological states such as diabetes and uraemia. In unconsciousness due to alcoholic excess, the previous history may give a clue to diagnosis, as also may the smell of the breath. This sign, however, may be misleading, as the stimulant may have been taken at the onset of faintness, for its restorative effect. In alcoholic unconsciousness, the pupils are usually dilated, the face flushed, the pulse rapid; and the brain may be so completely anaesthetized that not even supra-orbital nerve pressure will provoke a reaction. Occasionally severe vomiting may occur, with threatened collapse, the features becoming pale, cold, and drawn, and the pulse-rate slow. The treatment consists in the putting of the patient to bed with hot-water bottles, administering an emetic, and, when recovery has begun, giving hot coffee or tea. In severe cases, medical aid should be obtained.

The unconsciousness of epilepsy follows the violent manifestations of the seizure. The fit, which is often dramatic in its suddenness, is sometimes preceded by a warning preliminary cry. The victim falls at once, wherever he may be, and fatal accidents often happen in consequence. The whole body is rigid and stiff, and, as the respiratory muscles are included in the muscular spasm, blueness of the face and lips from insufficient aeration of the blood is a common symptom. This period of rigidity lasts for a minute or so, and is followed by a stage of involuntary movements; the arms, the legs, the trunk, the tongue, and the lower jaw being jerked convulsively. After a variable time, these movements cease, but unconsciousness persists, changing imperceptibly into heavy sleep, from which the patient wakes dazed and with a headache. Very often, bowel and bladder control is lost during the attack, giving a definite indication of the epileptic origin of the fit.

Known epileptics should, so far as is possible, be protected against the risk of a dangerous fall. The blueness of the face and lips in the attack, though alarming, calls for no treatment. Preparation must, however, be made for the convulsive stage. As the rigid spasm begins to pass, an attempt should be made to insert a gag of some kind between the teeth, to prevent biting of the tongue during the convulsion. This should not be too hard; wood and rubber being suitable materials. The thickness of the wedge should be just enough to prevent the jaws being closed. The clothing should be loosened. Movement must not be forcibly restrained, but the patient should not be allowed to injure himself by contact with surrounding objects. He should be left to sleep off the fit; and, if he can without much disturbance be

moved to a quiet dark room, so much the better. It is wise in all such cases to call in a doctor. Much can be done by treatment to check the frequency and lessen the severity of the attacks.

Unconsciousness may be due to injuries to the head, to acute intra-cranial states, to concussion, and to compression, with which may be included apoplexy, which causes pressure on the brain from within.

Moderately severe jolting of the skull, such as occurs in a knock-out blow or in a fairly heavy fall, is responsible for concussion. The cells of the brain are temporarily disarranged; and a train of consequent manifestations follow. The higher functions of the brain are in abeyance, as varying degrees of unconsciousness show themselves. Occasionally, in less severe injuries, the mind is merely dazed. In any event, the stupor or unconsciousness is generally of quite short duration, lasting but a few minutes, though at times a much longer interval may elapse before consciousness fully returns. Associated with this out-standing symptom, is a considerable lowering of the body temperature, together with pallor and cold sweating. The limbs are motionless; and, as recovery sets in, there is still noticeable unwillingness to move. The pulse is feeble, at times almost imperceptible, and its rate is extremely rapid—even up to a hundred and forty beats a minute. Respiration is shallow, so that the breathing movements are sometimes almost undetectable. The pupils of the eyes remain equal in size, though they may be larger than the normal.

Recovery usually sets in spontaneously and quickly; and little first-aid treatment is called for. There is, however, a latent risk attending all, even apparently mild, head injuries; and medical aid should be obtained, no matter how trivial may seem the initial manifestations. Keep the patient recumbent, loosening the neckband and any other constricting garment, and maintain the body temperature with coverings and hot-water bottles. On no account must any stimulant be given; as, should there be some concealed intra-cranial injury, a fatal termination may thus be provoked. As a working rule a two-hour period of observation should be kept after all symptoms have cleared up.

Compression is a far more serious state than simple concussion. The term implies a pressure on the brain due to a sudden increase in the contents of the skull. Such an increase is usually due to haemorrhage; which, in its turn, may be caused by a fracture of the skull bone. If there is no fracture, the bleeding may result from rupture of the blood-vessels lining the inner surface of the skull, or of vessels in the substance of the brain itself. This condition is known as apoplexy. The outlook in such an accident is, of course, very grave. In contrast with its condition in concussion, the surface of the body during the apoplectic stage is flushed and warm. The unconsciousness is extremely deep, and pressure on the eyeball may provoke no reaction or visible reflex. The

motor power is particularly affected. Not only is there a complete absence of movement, due to the stupor, but one side of the body—in the early stages at least—appears paralysed. If both arms are lifted and allowed to fall, there will be an appreciable difference in their drop. The arm on the paralysed side will fall with a heavy thud, which, compared with that of the other side, is unmistakable. The pupils are, at the onset, unequal. This is a cardinal and easily recognizable feature. The inequality persists till complete paralysis of the light reflex has occurred; that is, where there is no alteration in the size of the pupil under a beam of light. The pulse-rate is slow, and the tension is bounding—unlike that of the pulse in concussion, where it is feeble and rapid. Respiration is slow, deep, and very noisy. On careful observation, paralysis of one side of the face may be recognized by the puffing out of that cheek during expiration. Examination of the skull may show signs of a fracture of the dome or vault. Concealed fracture of the base of the skull may give rise to an escape of blood or cerebro-spinal fluid—water-like, and possibly tinged with blood—from the nose, mouth, or ear. A black eye often develops when the front portion of the base has been involved.

Any acute superficial bleeding may be controlled by an improvised tourniquet applied to the circumference of the skull in such a manner as not to press on the fractured portion, if such exists. The nose or ears must in no circumstances be plugged, even if blood is escaping from them. Little can be done, or should be attempted, in such injuries. Raising the head is sometimes advised, but such treatment does not appear to have any physiological sanction. All constricting clothing should be loosened, and a clear air-way should be secured by turning the head to one side and holding the jaw forward; by which procedure the tongue is prevented from falling backwards and occluding the entrance to the windpipe. Medical aid should of course be obtained as quickly as possible. Meanwhile, nothing should be given by the mouth.

Fainting Attacks

The ordinary fainting attack is due to a sort of anaemia of the brain—owing to a partial failure in the supply of blood to the head. Seeing that, when we are standing upright, the brain is at our highest point, and that, accordingly, any falling-off in blood-pressure will be most marked there, we are far more likely to faint when we are standing up than when we are sitting down—still more than when we are lying down. From this, the reader will understand why it is that the doctor, if one is present, always orders a person who is feeling faint to be laid down on a bed, or on the floor. Nature, when she makes a fainting person lose

consciousness, prescribes, in her rather peremptory way, the same treatment as does the doctor. A fainting person falls to the ground, and usually remains there until his blood-pressure has recovered its normality. In ordinary life, through the action of forces which we need not now discuss, a very large part of the total blood-canal system is closed down—the sections thus closed down varying as different parts of the body are resting or active. The regulating mechanisms have an intimate relation with impressions made on the surface of the body. They act most effectively when we are moving about, enjoying a cool, fresh breeze on a sunny day; and least effectively when we are in ill-ventilated rooms with a lot of other people; or on close, sultry days in summer, when the air is hardly moving and is heavily charged with moisture. In such circumstances our blood-vessels 'lose tone,' and become dilated and flabby, the blood-pressure falls, and the brain, being at the highest point of the body, does not get its full share of blood. Thus we may experience almost all the symptoms of haemorrhage without a drop of blood escaping from the body. We can, as it were, faint, or even die, through bleeding into our own flabby blood-vessels.

The treatment of a fainting attack is simple. If the patient has not already fallen to the ground he should be laid down, thus giving the brain its share of what blood is available. If he can be dragged into the cool, open air, so much the better. Cold water may be sprinkled in the face, and a bottle of smelling-salts or ammonia intermittently applied to the nostrils. Any tight clothing should, of course, be loosened.

Strains, Sprains, and Bruises

Simple bruises, when the skin is not broken, are well treated by laying on them a cloth wrung out in cold water and methylated spirit. After a few hours the cooling application may be replaced by warm fomentations in order to promote freer circulation through the part.

Strains of muscles and sprains of joints demand immediate rest for the injured part. The pain which usually accompanies these conditions is apparently due in part to the effusion of fluid into the tissues, in part to the spasmodic contraction of muscles endeavouring to prevent movement of the injured parts. After a day or two of complete rest, gentle movement of the joint or strained muscle is desirable. If movement is still very painful an elastic or other bandage may be applied with moderate, though not too great, firmness, and gentle movement be persisted in. Three or four times a day the affected part may be gently massaged for five minutes, in order to assist in the distribution of such effusion as may be stagnating. If there is any question of a bone injury, be it ever so slight, a doctor's advice should be obtained before any treatment is attempted.

Embedded Needles and Hooks

A common accident is the embedding of a needle in the flesh. When, as sometimes happens, the needle breaks off in the tissues, a surgeon must deal with it; but, where the end is still accessible, it should be seized with a pair of forceps or small pliers, and so withdrawn. Should a fish-hook have pierced the skin, rather than trying to push it back—a course which usually adds considerably to the laceration of the wound—it should be pushed onwards, so that the barb may come to the surface; when, with a pair of cutting pliers, the barbed end may be removed, and the barbless hook can usually be easily drawn out. Where a splinter has penetrated the nail-bed, a pair of very sharp narrow scissors should be employed to cut a V in the nail above the site of the splinter, facilitating its removal with an appropriate instrument.

Foreign Bodies in the Nose, Ear, and Eye

If a foreign body lodges in the nose it is best to leave the surgeon to attempt withdrawal. The mucous membrane of the nasal passages is easily injured, and unskilful attempts at extraction may wedge the substance still further in.

If a seed, dried pea, or some such object, has found its way into the ear-passage, it is as well to leave its extraction to more experienced hands. If, however, it is an insect that has crept or flown into the ear, it may be brought to the surface by floating it out on oil—warmed olive oil answering the purpose quite well.

Foreign bodies in the eye constitute far the most usual of these accidents, and may lead to undesirable consequences. The smallest speck on the sensitive eye-ball feels enormous, and sets up inflammation in quite a short time. The substance usually gets lodged in the little gutter on the under surface of the eyelid, about a quarter of an inch from the eyelash border. Take a clean handkerchief, rolled to a point at one corner; or, preferably, a camel-hair brush which has been soaked in castor oil. Seat the patient in a good light, and evert the eyelid. With the left hand secure a good hold on the eyelashes, and get the patient to keep looking downward. With the right hand press lightly a quarter of an inch behind the lash margin in a downward direction, using a match-end or a blunt pencil as a sort of lever, till the inner surface of the eyelid is exposed. Find and remove the speck with light wipings of brush or handkerchief, and then instil into the eye a few drops of castor oil.

Occasionally particles of metal or of flint become embedded in the eye. These call for treatment by the surgeon. Amateur efforts at removal may end in permanent damage to the sight.

XXVI—SOME DANGER SIGNALS

THE amateur doctor is apt to be as great a nuisance as the family oracle; and he is far more dangerous. Although no one is more conscious than is the trained doctor of the limitations of his knowledge and of his power over disease, yet he is in possession of the sifted tradition of generations of professional men whose lives have been spent in the contemplation of illness and in its treatment. Yet, so frequent are the minor accidents that befall us, and the minor disturbances of health to which every one of us is subject, that it would be absurd to rely on specialist advice and help on every occasion, however trivial. There are people who rush for the doctor every time they have a stomach-ache, or a headache, or an emotional anxiety. But such dependence is no more commendable and no more wise than is the opposite course. The difficulty consists in safely discriminating between those divagations from the normal that are essentially trivial and evanescent and those manifestations which, though not in themselves distressing or alarming, are yet indicative of the possible approach of grave danger.

It is difficult to define other than tentatively the circumstances that should impel every one to seek skilled advice; that is, to consult the doctor. A few may be enumerated here.

Any febrile attack—that is, an illness attended by rise of body temperature—that does not clear up within twenty-four hours.

Any extensive burn or wound, even if little haemorrhage attends it.

Appreciable and continuous loss of weight, extending over more than a month or so.

Pain in any part of the body—especially in the chest or abdomen—which continues for more than a couple of days.

Any abnormal lump or swelling observed in any part of the body.

Any fainting attack, however evanescent; or any abnormal shortness of breath on slight exertion.

Any cough that continues for more than a few days; and, of course, any coughing or vomiting of blood.

Persistent vomiting or diarrhoea; or, on the other hand, persistent constipation.

In women, the occurrence of any uterine haemorrhage or discharge after the menopause or change of life.

Any skin rash or irritation that does not clear up within a few days.

Any local inflammation, whether known to be connected with a scratch, or wound, or not.

Especially in children, any sore throat or earache that does not clear up within twenty-four hours.

Any decline in the general feeling of well-being which, in spite of reasonable self-prescribed measures, persists over a period of weeks.

Any difficulty in passing water; or any abnormality in the appearance or amount of the urine.

Any deterioration in sensory appreciation—that is, in power of sight, or of hearing, or of smell, or of touch.

Any wasting of muscle or loss of muscular power, local or general.

Any sign of decay of the teeth, pain in the dental region, or sensitiveness of the gums (in this case, it is the dentist rather than the doctor who should be visited).

This list includes but a few outstanding conditions of which the possible sinister developments may not be realized by the layman; it by no means exhausts the circumstances in which technical advice may prudently be sought.

Photos by Barbara Wagstaff

ARTIFICIAL RESPIRATION

Schäfer's Method

XXVII—THE ART OF NURSING THE SICK

General Reflections on Nursing

MAKING THE PATIENT COMFORTABLE.

THE words 'nurse' and 'nurture' come from the same root. And to nurture does not mean merely to feed; it means also to protect and cherish. All sick people, even the most fractious and tyrannical, like to be cherished. It is a symptom of their state. In illness we regress a little towards our childhood, and expect to be managed and reassured as we were in our early years. The born nurse knows, without being told, exactly how to manage and reassure a patient, but one does not have to be a born nurse to be a good one; any sensible person with tact and judgment can learn how to make a patient comfortable and set his mind at rest. In this respect the nurse is considerably more important than the doctor. A medical man who had pneumonia reported afterwards that the doctor's visits nearly killed him, but that the nurse had saved his life. The doctor, of course, had to examine him, and the business of having his chest sounded seemed almost intolerable to the sick man; on the other hand the nurse, he said, used to make him comfortable, and leave him alone.

The phrase might serve as a slogan for all nurses. Never do as much as you can for a patient; do only what you must, and leave him in peace. And whatever you have to do, do it quickly.

CHOOSING THE NURSE.

When a patient has to be treated at home there is often no choice of nurse; the person whose engagements are most fluid—usually the mother of the family—is forced to assume that office. But if you belong to one of those rare households where there are several potential nurses to choose from, it is worth while considering at the outset which one has the most flair for nursing.

When the patient is a child the situation is delicate. The mother is sure to think that she is the best person to nurse him. But is she? Sometimes she is, no doubt, but sometimes her very preoccupation with the child makes her the worst possible person to have anything to do with him. The agonized face of his mother asking: 'Darling! How do you feel now?' has sent many a child's temperature rocketing. If you are not this kind of mother you can safely insist on looking after

your child yourself; but if you feel a little doubtful you will be kinder to your child if you let someone else look after him.

The people who make the best nurses are those who are serene and intelligent. If a patient is going to be ill for a long time it is unwise let someone stupid look after him simply because she happens to be the person with most time on her hands. A very sick patient will scarcely notice whether his nurse is stupid or not (though his safety may be endangered if she is), but as soon as he becomes convalescent stupidity in the nurse will fret him past bearing, and delay his recovery. A deaf nurse, too, is a severe trial to any patient; if he is gravely ill he will find it requires an effort to speak at all, and even when he becomes convalescent he will find shouting a labour. An anxious, fussy nurse is equally wearing; and so is the kind who treats the patient as though he were helpless and half-witted long after he has got past the helpless stage. A good nurse is quietly confident in everything she does and says. However alarmed she may feel she never lets it appear in her face and voice. People who are seriously ill are often frightened in their hearts, and they derive great comfort from a nurse who can make them feel that they are not really as bad as they think they are. If the nurse looks anxious and speaks in an urgent voice, the patient assumes that he is on his last legs, and his fear becomes panic. On the other hand, it comforts him to be told affectionately that he is a bit of a fraud; he will not believe this even when it is true, but it will lighten his dismay.

CO-OPERATING WITH THE DOCTOR.

The best nurses do not criticize the doctor to the patient, not necessarily because they think the doctor infallible, but because they know it saps the patient's confidence to hear his sagacity doubted. The doctor relies greatly on the observation of the nurse, and he will appreciate a clear account of the patient's state when he makes his visit. Countless hours are wasted daily and the lives of medical men are shortened by the inability of most people to tell a plain tale plainly. When a doctor takes the history of a case the interrogation usually proceeds on the following lines:

Doctor. Well, Mr. Robinson, what 's the trouble?
Patient. That 's what I want you to tell me, doctor.
Doctor. Well, what are you complaining of?
Patient. Oh, I 'm not a one to complain. I——
Doctor. Then what have you called me in for?
Patient. Well, I put it all down to a chill on the liver.
Doctor. Yes, but tell me what you notice wrong.
Patient. Oh! It 's the gastric.
Doctor. And how does that show itself?
Patient (at last). I get pains in my stomach.

Of course the patient is only trying to be helpful, but he is wasting valuable time; the doctor does not want to hear the patient's diagnosis—he wants to know the symptoms.

The nurse can help considerably by telling the patient beforehand to listen to the doctor's questions, and to answer what he asks. The ideal interrogation would run something like this:

Doctor. Well, Mr. Robinson, what 's the trouble?
Patient. I get pains in my stomach.
Doctor. When do they come on?
Patient. Half an hour after food.
Doctor. How long have you had them?
Patient. This attack began on Tuesday, but I 've had the same thing, on and off, for two years.

The good nurse will not only ensure that the patient gives his history in this enlightened manner, but will keep her own answers strictly to the point. The doctor will probably want to know how the patient sleeps, whether his appetite is affected, whether he has vomited or has a cough, whether he has noticed anything wrong with his motions or his urine, and whether he has had a shivering attack or has been sweating more than usual. It will save time if the nurse sees that the patient has the answers to these questions pat. When the doctor has examined the patient, listen to what he has to say, and follow his advice. After all, we call in the doctor so that we may profit by his wider knowledge and experience, and common sense should teach us to make the most of them. Some people adopt the manner of the vicar's wife in *Punch*: 'Well, doctor, I say it 's influenza. What 's *your* humble opinion?' This is hardly co-operation.

Nor is it helpful to listen attentively to all he says, only to find that you have forgotten it when he has gone. If you think that you may not remember his instructions, take a few notes while he is there, and never be afraid to ask questions. You will be wise, too, if you ask him to explain in ordinary words what has gone wrong with the patient; if you have a clear idea of the trouble in your mind you can use your judgment to better advantage. The doctor will be only too ready to give you all the help he can.

ARRANGING THE ROOM.

In general, the sick-room chosen should face south or south-east, so that it gets the morning and midday sun. This advice should be followed with discretion, for if the patient has an acute feverish illness in the middle of a hot summer you will do well to nurse him in the coolest room in the house. The bed should stand out of a direct

draught and should have its head against the wall with a clear space at either side. If the illness is likely to last more than a few days, or is infectious, rugs and carpets should be removed and replaced by washable rubber or cork-lino mats. As little furniture as possible must be left in the room; chairs should be of plain wood, and the remaining pieces should include a chest of drawers, a table, a wash-stand, and a bedside cupboard. Remove unnecessary hangings and curtains; if pictures are left on the walls let them be few and cheerful, in simple frames. A plain wallpaper is highly desirable if the patient is to be ill for any length of time; grown people annoy themselves by counting the checks or stripes which go to form a pattern, and children have a knack of finding terrifying faces among the exuberant flora of the older types of wallpaper.

The sick-room is best heated by a coal or gas fire, both of which promote ventilation; a bowl of water may be placed in front of a gas fire, to prevent the air from becoming too dry. There should always be an open window in the sick-room, except while the patient is having a blanket bath. To air the room thoroughly open the window at top and bottom; the hot stale air will flow out above and fresh air will flow in below to take its place.

Never let the sick-room become a gloomy place. Rows of bottles on the bedside table are a dismal spectacle; put the bottle away in the cupboard as soon as you have administered a dose of medicine. Flowers help to keep the atmosphere fresh in the daytime, but they may be taken out of the room at night, as they keep fresher in the dark.

The room should be cleaned quietly and quickly by the nurse during the course of the morning—that is to say, after the patient has breakfasted. He should never be wakened before his time with unnecessary bustle. The floor should be cleaned with a mop or a duster tied over a broom, so that no dust is stirred up. The fire should not be laid by the nurse, because she might graze her hands and thus open the door to infection, but it ought to be done by someone who will not make a clatter. Indeed, it is wise to dispense with all fire-irons from the outset except a light poker; a glove can be used for putting on coal.

Running water in the bedroom is a great advantage and is more commonly obtainable now than it used to be. In any case the room chosen should not be too far away from the bathroom or some other source of running water; and if constant hot water is available, so much the better.

'KEEPING UP HIS SPIRITS.'

The idea that a patient must have his spirits kept up is widely prevalent. It is true that a sick person's fund of spirits is low, but this seems to be rather an indication that he should hoard them than that he should

expend them recklessly. Those who visit the sick with a view to cheering them up should bear this in mind. A visit from an entertaining friend may be most successful while it lasts; the patient may become animated and talkative, full of amusing comments on his own condition. But the departure of the guest is apt to leave him limp, with little energy remaining for the business of getting well, which, after all, is his first duty. A good nurse will manage to keep these well-meaning friends away from her patient until he is convalescent, and can profit by their kind offices; and she will also take care not to fall into the same pitfall herself. Too much stimulating conversation drains the vitality of the sick person, and as a rule he prefers to do without it. A sick animal creeps into a corner and avoids companionship, and a sick person would do the same if he were allowed. This is Nature's hint that peace and quiet are the best healers.

When the patient becomes convalescent it is a very different matter. He soon lets his nurse know that he is bored, and now his lively visitors are really welcome. This is the time for the gramophone, light and thrilling literature, a piece of amusing, quickly finished needlework for the woman patient, and above all, the wireless set. It is a mistake to place the wireless out of reach of the patient, turn it on, and go away. You may come back to find him the victim of an inappropriate sermon or prostrated by political opinions which it has been impossible for him either to endorse or ignore. Most young patients will prefer to mess about with the switches themselves, picking up foreign stations; older people will be grateful if you find them a congenial programme, and leave them within reach of the switch, so that they can turn it off when they have had enough of it.

If there is a window to the sick-room with an interesting view the convalescent patient will like to be placed so that he can look out of it. Even—or perhaps especially—if it overlooks a street it will provide endless amusement for an idle person, and the most austere recluse will find himself becoming a gossip under these happy conditions.

The Type of Case you Nurse at Home

Illnesses nursed at home are becoming steadily fewer as science demands more elaborate apparatus for diagnosis and treatment. Major operations are now rarely performed on the dining-room table, and even the acute infectious fever cases are generally whisked straight off to hospital. Some readers may reflect glumly that their experience has been confined to influenza, sprained ankles, and bilious attacks, and these certainly form the backbone of the practice of the home nurse. But there are some other conditions which may call for treatment at

home, about which the nurse needs to be forewarned; they may be classified as follows:

1. Acute cases:

   Cold in the head, influenza, pneumonia.
   Acute infectious fevers such as measles, chicken-pox, whooping-cough, German measles, and sometimes scarlet fever.
   Digestive disturbances.

2. Chronic cases:

   Chronic rheumatism and chronic bronchitis in old people.
   Surgical tuberculosis in children.
   Diabetes and pernicious anaemia.

3. Accidents:

   Sprains, fractures, cuts, and bruises.
   Burns and scalds.

4. Convalescence:

   From illness.
   From operations, such as abdominal operations and operations for the removal of tonsils and adenoids.

The special nursing measures appropriate to these various conditions are dealt with later; but before discussing these it will be as well to consider some general nursing measures which may be required in any illness.

General Nursing Measures

PERILS OF THE CLINICAL THERMOMETER.

The clinical thermometer is a good servant but a dangerous master. There are some homes into which it should never be allowed to penetrate. If you find yourself flying to the drawer where you keep it on the least pretext; if the mildest elevation of temperature in the victim sends a pang of misgiving through you, and drives you to telephone wildly for the doctor; if, above all, you can look back over a few months and recall that the number of unexplained feverish attacks in your family have increased in number since you bought the wretched thing—then you will know that you are not a suitable person to possess a clinical thermometer; and you will be well advised to break it and forget to buy a new one. But if you are content to let it lie peaceably in its place, only bringing it out when your judgment tells you there is some cause for anxiety, you will find it a useful guide.

When buying a thermometer always buy the half-minute sort. The

thermometer is graduated in degrees and the interval between each degree-mark is divided into five; each of these five small divisions, therefore, represents two-tenths of a degree. So that if the mercury stands at the second small division above the 98 degree-mark, the temperature registered is 98·4°, which is normal, and if it stands at the third small division above the 100 mark, the temperature is 100·6°. The chemist from whom you buy the thermometer will always show you how to read it.

To take the temperature, place the thermometer in the mouth of the patient underneath the tongue; and though you have been careful to buy the half-minute kind, leave it in for at least two minutes. Even the best thermometers need plenty of time to register. When you are taking the temperature of your adolescent son he is quite likely to get a little harmless pleasure out of stirring his tea with the thermometer, and this will produce an interesting peak in the temperature chart. A similar error in reading may occur if the patient has had a hot drink just before the temperature is taken. It is better to wait for about an hour in this case, so that his tongue and cheeks may have time to cool down again. To take the temperature of a young child place the thermometer in the armpit and keep his arm folded across his chest for several minutes. With babies the thermometer can be placed in the fold of the groin, the leg being bent up against the abdominal wall. The thermometer takes longer to register in these positions, and the readings are likely to be lower than those recorded in the mouth.

When you have taken the temperature, wash the thermometer in cold water, rub it with a clean towel or piece of lint or linen, and put it away. If you put it into hot water the expanding mercury may burst the glass. It is better to keep the reading to yourself, and take care lest your face plays the part of a second thermometer in registering your emotions. A look of horror and a cry of 'My goodness! A hundred and three!' will awaken alarm and despondency in any patient; even the look of horror alone may be enough. If the temperature is raised you will be wise to pass on the responsibility to the doctor. Subnormal temperatures mean very little unless the patient is extremely ill and collapsed. While the thermometer is in the patient's mouth it is usual to count the pulse-rate. This is done by placing two fingers on the patient's wrist, just above the root of the thumb; you can feel the lower end of one of the forearm bones, the radius, just here, and the radial artery runs across it. Compress the artery slightly between your finger-tips and the bone, and count the beats. If you are not expert it is as well to count them for a full minute. The normal pulse-rate is 70–80 beats to the minute; in children under the age of seven the rate is more frequent, ranging from 70 to 120 beats a minute. Usually the beats are regular, and an

irregular pulse should be reported to the doctor. In some children, however, the beats become more frequent as the child breathes in, and slow down again as he breathes out; this means nothing at all, and need not alarm you.

After taking the pulse you can fill in the next minute, before removing the thermometer, by counting the respiration rate; the normal rate is 16–20 breaths a minute, but if the patient is feverish the rate is likely to be increased and in pneumonia it becomes very rapid indeed. If the patient realizes that you are counting his respirations, the rate is almost certain to change because he will become interested in it himself; the best plan is to go on holding his wrist as though you were still taking his pulse, and to watch his breathing surreptitiously.

MAKING THE BED.

The bed should have a clear space at either side of it, so that the patient can be moved, and sheets be changed, without difficulty. A horsehair mattress is to be preferred to any other kind. The bed-clothes should consist of an under-blanket, long enough to tuck in lightly all the way round; an under-sheet put on in the usual way; a mackintosh-sheet stretched across the middle of the bed and tucked in well at the sides, and over it a draw-sheet—which is a strip of sheeting wide enough to cover the mackintosh—also tucked in at the sides. Covering the patient there should be an over-sheet and two or three blankets. The blankets must be warm but light in weight; heavy bed-clothes are oppressive and cannot be borne by an ill person. Two or three feather pillows and one of down will make his head and shoulders comfortable.

To change the draw-sheet, turn the patient on to his right side and untuck the draw-sheet at the left side of the bed. Roll the free half of the draw-sheet up until it lies in a long sausage against the patient's back. Have the clean sheet ready rolled up to half its width in the same way, and place the rolled half of the clean sheet down the middle of the bed, alongside the rolled half of the soiled one. Tuck in the free end of the clean sheet at the left side of the bed. Now turn the patient gently on to his left side, and draw the two rolls of sheet under him, unrolling the clean one as you go; untuck the end of the soiled sheet at the right side of the bed, and tuck in the clean one; make sure that there are no wrinkles in either the sheet or the mackintosh; wrinkles are the forerunners of bedsores.

The draw-sheet can be changed as often as necessary, without much disturbance of the patient, and the under-sheet can be changed in the same way when required.

CARE OF THE PATIENT'S BOWELS.

Some people take a purge regularly once a week, or even once a day. This is probably a mistake, as it leads the bowel to expect an artificial stimulus before it will act. It is better to take a sensible diet and to acquire regular habits, reserving purgatives for unexpected attacks of constipation. But the time to change a patient's usual custom is not while he is ill. If he is used to taking a daily purge you will probably have to continue the dose, and even increase it, while he is at rest in bed. Every mother knows, too, that a feverish attack in a child is generally benefited by a dose of senna or of a simple saline aperient. Fortunately that old favourite, castor oil, is losing its following; castor oil, after producing an action, leaves the bowels constipated, and though it is useful in some conditions, it should be left to the doctor to prescribe it.

But there are exceptions to every rule, and there is one feverish illness in which it is extremely dangerous to give a purge. This is appendicitis. An untimely dose in this condition may cause an appendix abscess to rupture into the abdominal cavity, producing peritonitis, and placing the patient's life in grave danger. You will want to know, therefore, what signs should make you suspicious enough of appendicitis to call in the doctor. The temperature as a rule will be raised; the patient will complain of abdominal pain, but this will not necessarily be limited to the appendix region (which lies low down on the right side of the abdomen). It may be felt most at the region of the navel, or it may radiate over the whole abdomen; the patient will, as a rule, look ill, and those who know him best will be able to detect slight changes in his colour and appearance which a stranger might miss; he will probably feel some tenderness if you press your hand gently over the appendix region, and the muscles of the abdominal wall may feel hard just there; he will generally be constipated; he may vomit. If all or some of these signs are present send for your doctor. On no account give the patient a purge first.

When a patient is ill in bed, his bowels need particular attention. If he is well enough, he can use a commode placed at the side of the bed. The pan should be taken from the room as soon as he has used it, and unless the doctor has asked to see the stools, should be emptied and washed out with disinfectant. When keeping the stool for the doctor to see, cover the pan with a sheet of glass, if you have one, or a plate, place a cloth over it, and stand it in the open air if possible. If the patient is too ill to use the commode he will need a bedpan. The slipper shape is generally more convenient than the round sort. Before passing it, warm it well in hot water and dry it, or put it before the fire, but take care lest one part of it becomes hot enough to burn the

patient, while the rest of it feels quite cool. Put the patient on h back with his knees drawn up, and pass the bedpan beneath hin Remove it after five or six minutes, as the patient must not be allowed t strain. Cover the pan with a clean cloth, and take it immediately fro the room, coming back to open the windows widely before you empt the pan.

If the patient is obstinately constipated, or if, for some reaso purgation is not desirable, the doctor may ask you to give an enem For this purpose you will need a Higginson syringe, which consists of rubber bulb with a narrow tube at each end; one tube lies in the basi of fluid to be injected, the other is fitted with a nozzle for insertio into the patient's anus. To give a plain water enema, fill a basin wit water at a little more than blood-heat (i.e. about 99° F.). Put the fre end of the syringe in the basin, and gently compress the bulb so th the water runs out of the nozzle and is squirted back into the basi When you are sure that the syringe is working properly, turn the patien on to his left side, with his knees drawn up, and put a thick towel folded, under his pelvis to prevent the bed from getting wet. Mak sure that no air is left in the syringe, smear the nozzle with vaseline, an insert it gently into the rectum; the nozzle is fitted with a shoulder-piec which will prevent you from pushing it too far. Use no force; as th nozzle touches the anus the muscle will contract, and you must wait moment or two for it to relax before the nozzle will slip in. Inject th fluid very slowly until one or two pints have entered the rectum; th doctor will tell you how much fluid to give if you ask him. The actua injection should take five minutes or more. Afterwards withdraw th syringe gently, and make firm pressure at once on the anus to help th patient to retain the enema; if possible he should retain it for ten minutes

Sometimes the doctor will order a soap-and-water enema to be given About one ounce of plain white soap is flaked and dissolved in wate which has been boiled; this solution can then be diluted with anothe pint of warm water. A glycerine enema consists of a teaspoonful o pure glycerine, and is usually given with a special small glass syringe When the patient has a great deal of flatulence the doctor may orde a turpentine enema; this is made by adding one or two tablespoons o turpentine to a pint of soap and water, and is given in the usual way.

LIFTING THE PATIENT.

If a patient slips down in bed, bend his knees so that his feet rest fla on the mattress. Slip your hand under his shoulders, and grasp hin under the opposite armpit, allowing his head to rest in the bend o your elbow; put your other arm under his thigh, bend your knee slightly, and lift. If he is too heavy to move alone, get someone els to help you, standing on the opposite side of the bed; grasp the patien

under the far armpit as before, but place your other arm under the small of his back. The other person should put one arm under his thighs and the other under the small of his back, alongside yours; you must both lift at the same moment.

WASHING THE PATIENT.

For some reason, most of us dislike being washed by somebody else; it is a clammy, froggish business. As soon as the patient feels equal to it, then, let him do part of his own washing at least, and until that time perform his ablutions as quickly and inoffensively as possible. He must be washed all over once a day, or his skin will develop sweat-rashes and bedsores. Begin by closing the window and putting a screen round the bed; then collect within easy reach all the things you are going to need. These are: a large mackintosh sheet; two towels and two blankets which have been previously warmed; a hair-brush and comb; a bath sponge, soap, and nail brush in a receptacle big enough to hold them conveniently; a soft face flannel, or a bowl containing cotton-wool swabs; a bowl of warm water and a can of hotter water to replenish it; a newly filled hot-water bottle. Turn down the bed-clothes to the patient's waist, and lay one of the warmed blankets, folded, across his chest; turn the bed-clothes over the foot of the bed on to a chair, bringing down the warm blanket to cover him as you do so. Now turn him on to his left side. Have the other blanket and the mackintosh sheet rolled together to half their width, on the same plan as that used for changing a sheet. Place the roll against the patient's back, and spread the free part of the blanket and mackintosh over the right half of the bed, with the blanket uppermost. Turn the patient on to his right side, draw the rolled blanket and mackintosh under him, and spread them smoothly; he is now lying between two warmed blankets, with the mackintosh sheet between the lower blanket and the mattress. Put the hot-water bottle at his feet, take off his pyjamas, and begin.

First brush his hair; if the patient is a woman with long hair, braid it into plaits and fasten it out of the way. Then sponge the face with warm water, and wash the ears quickly but thoroughly with cotton-wool or the face flannel. When you have done his head and neck go on to his chest, arms, back, abdomen, legs, and feet, in that order, washing only one section of him at a time, and keeping the rest of him closely tucked up between the blankets. Dry each part carefully as soon as you have washed it, and pay special attention to his back and to all pressure points, using a warm towel to dry them, and powdering them afterwards; this will do much to prevent bedsores. The whole thing must be done quickly but without causing the patient to exert himself by hurried movements.

When you have finished remove the damp blankets and the mackintosh sheet, put him into clean pyjamas, and make up the bed; see that his water-bottle has not grown chilly, and give him an extra one if necessary. If he seems at all exhausted give him a hot drink.

FOMENTATIONS AND THE LIKE.

Any one who has had a septic finger can tell you more about boracic fomentations than the best textbook in the world. As a rule those who have suffered in this way assert that fomentations are put on too hot, too dry, and too seldom, and this is probably true.

To make a boracic fomentation take a piece of boracic lint so large that when doubled it more than covers the area to be treated; in shape it should be square, but with rounded corners and should be folded so that the fluffy side is inwards, and the smooth side out. Have ready a piece of jaconet and a thick piece of cotton-wool, both large enough to overlap the foment all round. Wrap the lint in the middle of a small face towel or clean piece of rag, and rest it in a bowl, so that the two ends of the towel hang over the sides. Now pour boiling water into the bowl so that the middle of the towel, containing the lint, is well soaked in it; after a moment or two take the towel by its two ends, and after wringing it out, untwist it and take out the foment, shaking it to cool it slightly. It is quite unnecessary to apply it to the patient at such a temperature that he shrinks or cries out with pain; a foment ought to be a comfort, not a penance. When the lint is in place cover it first with the jaconet, and then with the wool, and bandage it quickly. The doctor will tell you how often the fomentations should be renewed.

Occasionally the doctor will get you to apply a mustard leaf to a patient. To prepare the leaf you must dip it in tepid water, and wrap it in butter-muslin or aseptic gauze, only one layer of gauze covering the mustard surface. Apply the mustard side to the patient's skin and cover it with a towel. It must not be left in place for more than fifteen or twenty minutes, or the skin will be blistered. A mustard plaster is made by mixing one part of mustard with six parts of flour, and adding sufficient cold water to make a thick paste. Spread the paste on gauze or muslin, cover it with a layer of gauze, and apply it like a mustard leaf; this too must be removed after twenty minutes, or earlier if the patient has a tender skin.

Linseed poultices are still used sometimes, though they have been largely superseded by prepared substitutes in recent years. To make a poultice rinse out a bowl with boiling water, and then pour in a fresh supply from the kettle. Add crushed linseed rapidly, and stir it in with a knife. This must be done very quickly, and as soon as the mixture comes freely away from the sides of the bowl the poultice is ready. Tip it out on to a piece of flannel, and spread it out evenly, about

three-quarters of an inch thick. Turn in the edges of the flannel so that the linseed will not ooze out, and carry it to the bedside between two hot plates. Place it against the affected part of the patient with the linseed against the skin, and cover it with a piece of jaconet and a large sheet of wool, fastening it into place with a binder. It is usually necessary to change the poultice every three hours, making a new one each time. The patient should always lie on the poultice side so that he is not oppressed by its weight.

Nowadays antiphlogistine is more commonly ordered than a poultice; it is easier to prepare and is much lighter and more comfortable to wear. It can be bought in a tin from any chemist; to prepare it, stand the open tin in a basin of water, and heat the water until the antiphlogistine is as hot as you can bear it with comfort on the back of your own hand. Stir it round with a knife to make sure that the heat is evenly distributed. Smear a little vaseline over the patient's skin in the region to be treated, and then spread the antiphlogistine on to the skin with a knife. Cover it with a layer of gauze and a thick pad of cotton-wool, and fasten it into place with a binder. It can be left in place until it begins to crumble away from the skin, when it should be renewed.

Antiphlogistine can also be used as a dressing for an inflamed finger, or for a boil in the early stages. Another way of treating a boil is to paint it with collodion. Dip a swab of cotton-wool in collodion, and paint the boil in circular sweeps, leaving an opening in the centre through which the boil can rupture when it comes to a head. Sometimes this treatment is so successful that the boil never comes to a head at all.

There are also available for use in suitable cases preparations of cotton wool impregnated with skin stimulants. Of these Thermogene is perhaps the best-known example.

HOT-WATER BOTTLES.

Rubber hot-water bottles are pleasanter companions in bed than are stone or aluminium ones. A sick person may need more than one to make him comfortable. Bottles should always be provided with jackets, and, even though the patient is one who likes the water in them to be scalding, turn a deaf ear to his grumbles and give him only bottles on which you can comfortably rest your hand for any length of time. Unconscious people have from time to time been badly burnt by hot-water bottles, and even though your patient is not likely to lose consciousness, it is much better to be on the safe side. Some patients will consider this a hardship, and the nurse will have to change their bottles frequently if she is to avoid complaints. A tepid rubber bottle is a cheerless bedfellow in any case, enough to ruffle any patient's temper,

and chill his skin. The amount of water in the bottle may be varied to suit the taste of the patient; some like them plump and resilient, others like them pliable and slim. As long as the bottle is not over-filled and thus encouraged to burst, its contours may be dictated by the patient.

PREVENTION OF BEDSORES.

The hospital nurse thinks herself disgraced if her patient develops a bedsore, and the home nurse should cultivate the same attitude of mind. Bedsores are most likely to arise over points which are subject to pressure when a patient is lying in bed, such as the bony parts of the hips and back, the elbows, and the heels; thin people are more likely to develop them than fat ones, and older people than young ones. The great thing is to keep the skin in these regions dry. Change all bed and personal linen as soon as it becomes soiled or wet; pay special attention to pressure points when washing the patient, dry them very carefully, but never rub them too vigorously with a rough towel. When they are dry, wipe them over with a little spirit lotion to harden the skin, let it dry and then powder the danger points with talcum. If the patient has incontinence of urine or faeces, special care will be needed to prevent bedsores; he must have his linen changed as soon as it becomes wet and must have his skin kept as dry as possible. Zinc ointment may be spread over the thighs and buttocks, so that the moisture will run off the skin. A ring air cushion can be used to keep pressure points clear of the bed; the pressure point lies over the circular hole in the centre, and the rubber ring distributes the weight evenly among the surrounding areas of skin. Heels and elbows should be padded with wool, held in place by bandages. The wool must be frequently changed or it will become lumpy.

If an area of skin becomes red or purple and appears to be threatening a bedsore, avoid breaking the skin, but massage it gently with a slow circular movement, using a little spirit lotion; this will increase the circulation of the part. When restoring the patient to his normal position, make sure that no pressure falls on this area, and take particular note of it every time you have to do anything for him.

In the case of a chronic invalid a water-bed will help to prevent bedsores. The bed should be filled with water at 100° F., and you will have put in enough when you can still easily feel the lower surface of the bed by pressing the tips of the fingers on the upper surface. If, in spite of your care, a bedsore should develop, let the doctor know at once, and he will tell you how to treat it.

BANDAGING AND MASSAGE.

It would be out of place to give a long account of bandaging or massage in this section, but a few general principles may prove helpful.

Trained nurses will tell you that they take great pains to learn official methods of bandaging for their examinations, but that afterwards their chief concern is to make the patient comfortable. The following rules will help you to put on a bandage which is effective even when it is not strictly beautiful.

1. Make sure that the bandage is firmly rolled, and stand in front of the part to be bandaged.

2. Lay the outside of the bandage against the skin, so that you can hold the roll in your palm, and unwind it easily with your thumb.

3. Let each turn of the bandage overlap the preceding turn by about two-thirds of its width.

4. In bandaging a limb, work always from below upwards. When bandaging a foot and leg, for example, never begin by taking a turn round the ankle to give yourself a firm start; you may impair the circulation of the foot if you do. Begin your first turn at the base of the toes. The same principle holds in bandaging the hand: never take a first turn round the wrist.

5. Bandage a limb from within outwards, bringing the first turn across the front of the limb. This rule appears in all textbooks, but the manœuvre is difficult to visualize without some explanation. In the leg the position is fairly clear; the inner side of the leg is on the same side as the great toe. Suppose you wish to bandage the thigh; take the end of your bandage, and hold it against the inner side of the thigh with your left hand. Unroll the bandage little by little, carry it across the front of the thigh, then round the back of the thigh, and finally to the inner side again, where it overlaps the free end and fixes it, then carry it on upwards, spirally. In the arm, the 'inner side' is taken as being on the same side as the little finger. If you remember this, bandaging an arm becomes simple. Begin with the palm of the hand turned towards you. Lay the end of the bandage against the inner side of the arm, and carry the first turn across the surface of the arm facing you, then round the back, and finally to the inner side again; then carry on upwards.

6. In bandaging the body you should work away from the waist-line; that is to say, if you are bandaging the chest, work from below upwards, but if you are bandaging the abdomen work from above down.

7. A spiral bandage meets a great many needs, but in bandaging an ankle or some other joint it is often more convenient to put on the bandage in the form of a figure of eight.

Massage is not to be confused with indiscriminate rubbing. It is a safe rule never to massage an acute injury. 'Let me rub it,' says the well-meaning mother to her bruised and weeping offspring; and rub it she does, with the result that the child roars the louder. If you want

to ease the pain of a sudden bruise press your hand gently but firmly over the part, and keep up the pressure for about thirty seconds. The pain of a bruise is caused by the sudden exudation of fluid into the injured region, which takes place so rapidly that all the neighbouring tissues are stretched; if you maintain a firm pressure this sudden stretching is avoided, the tissues having more time to accommodate themselves to the changed conditions. Nor will a newly sprained ankle benefit by rubbing. After the first day or two massage is undoubtedly helpful, but not immediately after the accident. Massage should be reserved for chronic aches and pains, and for injuries that have passed beyond the acute stage.

The home nurse will probably be wise to confine herself to effleurage; this is simply a gentle stroking of the part under treatment. The operator sits in front of the part to be treated and uses the palm of her hand in a series of light even strokes, carried in the direction of the heart. At the end of the movement she does not remove her hand from the skin, but brings it lightly back to the starting-point. The stroking movements towards the heart should be gentle but firmer than the return strokes, so that the blood in the veins is carried forward in the direction which it normally takes. If some more complicated form of massage is required the doctor will probably arrange for the services of a trained masseuse. It is never wise to apply massage without first obtaining the doctor's approval. Some conditions, such as joint tuberculosis, and the acute stage of infantile paralysis, are so gravely aggravated by manipulation of any kind that the patient is likely to pay dearly for the mistake.

THE TREATMENT OF SHOCK.

In *Hamlet* the ghost cries:

> 'I could a tale unfold whose lightest word
> Would harrow up thy soul, freeze thy young blood,
> Make thy two eyes, like stars, start from their spheres,
> Thy knotted and combined locks to part,
> And each particular hair to stand on end,
> Like quills upon the fretful porpentine.'

You may think this is rather a fancy picture of shock, but if you have ever seen a person just after a serious motor accident, you will know that it comes alarmingly near the truth. The eyelids are drawn back, so that the eyes indeed seem to start, the pupils are widely dilated, and the mouth may be set in a grin of horror; although uninjured, the patient may not know where he is and may talk at random. It is hardly necessary to add that he needs soothing treatment. You will be wise

to get him to bed as soon as possible, and to call in the doctor, who will probably give him a sleeping draught. As a rule he will be calm again next morning.

This condition is rather different from so-called surgical shock, which is more like a state of collaspe. Surgical shock may follow operation, prolonged haemorrhage, severe burns, or acute exhaustion from any cause. The patient is pale and sweating, his hands and feet are cold, his lips livid, his pulse rapid and feeble, his breathing shallow. Send for the doctor, and get the patient into bed at once, rolling him in warmed blankets and packing him round with hot-water bottles. Tilt up the foot of the bed by resting the legs on wooden blocks or on several stout books piled up to a height of five or six inches. In shock, much of the blood collects in the large abdominal blood-vessels, and comparatively little is left to carry on the general circulation; by tilting up the foot of the bed you help the blood to run back towards the heart. Give the patient a hot drink of tea or coffee; when the doctor comes he will tell you what additional treatment is necessary.

Nursing Special Cases

COLD IN THE HEAD AND INFLUENZA.

The appearance of either of these complaints in the family calls for an act of dictatorship on the part of the home nurse. Send the patient to bed, and see that he stays there. People who nobly carry on their work while suffering from a bad cold are a menace to their friends. The only way to keep the spread of colds within bounds is to isolate the patient at the start. The experience of the last twenty years has shown us that influenza has a trick of becoming dangerous; if you suspect a case of influenza in the family call in the doctor at once. Beyond the need of this exhibition of firmness, the nursing of these cases is quite straightforward as a rule.

PNEUMONIA.

Doctors will tell you that the successful treatment of pneumonia depends on good nursing. Lobar pneumonia usually occurs suddenly in a previously healthy person; broncho-pneumonia often follows another illness, such as measles, whooping-cough, or scarlet fever, and it may also arise following a burn; old people confined to bed are extremely liable to develop pneumonia.

At the onset of lobar pneumonia the patient usually has a shivering attack, and his temperature rises quickly; he may complain of pain in the chest or abdomen, and he may vomit. Get him to bed and call in the doctor. His temperature will stay up until the crisis, usually

between the sixth and ninth days of illness, when it will suddenly fall; after the crisis the patient generally begins to mend. He must be nursed throughout the attack sitting up in bed, well supported with pillows, so that his distressed lungs can work as easily as possible. The air of the room must be kept cool and fresh, and he should be given plenty of fluids and such nourishing foods, in the form of egg-flips and meat jellies, as he can take. The doctor may order brandy to be given at intervals. The patient's mouth is liable to become dry and offensive, and herpes will probably break out on the lips; the teeth and gums can be swabbed gently with cotton-wool dipped in a simple mouth-wash, and the patient should be encouraged to rinse out his mouth several times a day. Burn—but not in the sick-room grate—all the material the patient coughs up. You will need a sputum cup to receive it. For the rest your task is to make the patient as comfortable as possible, to keep the linen of his bed fresh, and to look after his skin.

ACUTE INFECTIOUS FEVERS.

Nowadays smallpox, scarlet fever, diphtheria, and typhoid are usually nursed in hospital. Measles, which is a much more serious illness than the present type of scarlet fever, is unfortunately often nursed at home. Broncho-pneumonia is a common complication of measles, especially in young children. Your doctor will probably suggest that a child with measles should be given an injection of serum from a convalescent measles patient, in order to modify the attack, and that a similar injection should be given to those who have been in contact with the child, to prevent them from having the disease. If no convalescent serum is available, and the parents have had measles in the past, he may suggest that the father or mother should give some blood for injection into the children. You can safely accept either of these proposals with enthusiasm. Undoubtedly the lives of many children have been saved by modifying the attack in this way; and any healthy grown-up person can spare a sufficient quantity of blood for the purpose without feeling any the worse.

Whooping-cough may also be complicated by broncho-pneumonia, and should be taken seriously on that account. It is usually treated with respect in any case, because the paroxysms of coughing are so distressing to watch. Chicken-pox and German measles are seldom serious, and the chief problem of the nurse is to keep the child amused during the isolation period. Simple nursing measures meet the needs of most infectious fever cases; a wet or carbolized sheet hung outside the door of the sick room serves no useful purpose. If the temperature rises very high, the doctor may ask you to give the patient a cold sponging. Prepare the patient as for a blanket bath, but use cold water; sponge him in sections, beginning with his back, keeping the rest of him well covered. Put a folded towel under the part you are sponging, and be

prepared to make a mess; to sponge a patient effectively you must use plenty of cold water. Take fifteen or twenty minutes over it, and afterwards put the patient into clean pyjamas, make up the bed, and give him a hot-water bottle. The following table of incubation and isolation periods may prove useful to parents of growing families.

Disease	*Incubation period in days*	*Quarantine period after exposure to infection, in days*	*Isolation period after an attack of the disease*
Chicken-pox	10–16	20	When every scab has fallen off.
Diphtheria	1–10	14	Three negative throat swabs.
German measles	7–20	21	Ten days after disappearance of rash.
Measles	7–18	21	Three weeks after appearance of rash if there are no discharges.
Mumps	10–28	28	Three weeks from onset.
Scarlet fever	1–8	10	Six weeks if there are no discharges.
Typhoid	7–21	24	Three negative cultures from the stools.
Whooping-cough	7–14	21	Two weeks after the whoop is lost or eight weeks from the onset.

SORE THROAT.

If you are wise you will always get your doctor to look at any sore throats in your family. Most sore throats are not serious, but it is important to remember that diphtheria, scarlet fever, and measles usually begin with this symptom, and that, with diphtheria especially, early treatment may mean the difference between the survival and the death of the patient. In children tonsillitis is often a sign of acute rheumatism, and may be associated with damage to the heart. Repeated sore throats may mean that the tonsils need to be removed.

CHRONIC ILLNESS IN OLD PEOPLE AND CHILDREN.

Bed is a dangerous place for old people, exposing them to the risk of pneumonia. Never let them stay there after the doctor has said they may get up, and always nurse them sitting up in bed, well packed round with pillows to support them. Pay special attention to their skin at all pressure points, because they are more liable than are young people to develop bedsores. Children are seldom in bed for long periods unless they have some chronic disabling condition, such as joint-tuberculosis. These children will need all the fresh air and sunshine they can get. If they are being treated in a plaster of Paris splint, special care must be taken to prevent chafing of the skin, and to keep the plaster from becoming soiled with urine or faeces. The problem of nursing these children, however, is largely a psychological one; the nurse must have all her wits about her to prevent the patient from becoming either spoiled or sorry for himself, and to keep him amused and occupied. No rules can be laid down for her, because children vary so much in character. This is another of those cases in which the nurse chosen should be something more than a sensible person.

DIABETES AND PERNICIOUS ANAEMIA.

The early stages in the treatment of diabetes are best carried out in hospital, where the diet can be standardized and the right dosage of insulin determined under routine conditions. By the time the patient comes home he should be well enough to carry on an ordinary life.

Diabetes, however, is liable to become suddenly worse when the patient contracts a slight infection, such as a cold in the head or influenza; the home nurse must be on the watch for early symptoms of such disorders, and must see that the patient goes to bed the moment they appear. When he is in bed she should pay particular attention to the care of his skin, which will be much more liable to form bedsores than is the skin of an ordinary person. This peculiarity may lead to the development of ulcers on the feet of a diabetic patient who is otherwise in good health; the home nurse should therefore see that he always takes special care of his feet, and should thoroughly examine them every day to make sure there are no sore or chafed areas. The patient will have been taught to examine his urine for sugar before he left hospital, and it is extremely important that he should carry out this test every day; see that he does it.

The pernicious anaemia patient is to-day largely a culinary problem; advice on his care will be found in a later section.

ACCIDENTS.

Something has been said above of the care of sprains. The golden rule is: Never massage a sprain immediately after the injury, though

you may profitably begin once the acute stage is past. Let your doctor examine anything but the mildest injury, for sprains have a trick of turning out to be fractures of the tip of a bone. Treat sprains with rest and cold applications; if the doctor approves you can begin massage and gentle movements on the second day.

Fractures of the leg bones in young people are usually treated in bed. Boards should be put under the mattress, across the frame of the bed, to make a firm surface; the bed-clothes will have to be supported on a cradle, so that no weight falls on the leg. A temporary cradle can be made out of a stout cardboard box, or from a low stool; all you need is something to make an arch over the leg, strong enough to take the weight of the clothes. Nursing measures are otherwise as usual, except that it may be necessary, when the patient cannot be turned on his side, to change sheets from above downwards, drawing the rolled end under his shoulders; two people, one at each side of the bed, will be required to lift him while you bring the sheet under the pelvis. Fractures of the arm and collar-bone will not require nursing in bed as a rule, and fracture of the pelvis is best treated in hospital. The patient with a fractured skull must be kept completely at rest with his head between sandbags. Old people with fractures of the leg bones will usually be fitted with a walking-splint by the doctor because prolonged nursing in bed entails the risk of pneumonia.

Other accidents which may be nursed at home are cuts and burns. Severe cuts will usually be stitched by the doctor, and will merely call for a change of dressing or for fomentation if sepsis arises. Always scrub your hands well with soap and warm water for five minutes before changing a dressing, or doing anything which involves contact with the wound. Handle the clean dressings as little as possible, and always lift them from the back so that the surface you place in contact with the wound is quite sterile.

The modern treatment of burns is to spray them with tannic acid solution; this is a task for the doctor, but while you are waiting for him to arrive you will find that it eases the pain if you cover the burns with gauze dipped in tannic acid solution. Tablets for making up the solution to the right strength are now on the market, and you will be wise to keep some among your first-aid equipment. Never treat a burn with any oily substance; it interferes seriously with the use of tannic acid afterwards.

The Art of Feeding Patients

GENERAL PRINCIPLES.

Sick people often take more interest in their food than sound people think. After all, it is extremely boring to be ill, and before long the patient begins to think of his next meal as a pleasant break in the

monotony, just as passengers on a long sea voyage are apt to do. His appetite, however, is uncertain, and, if you present him with an unattractive dish, is likely to desert him altogether. The cardinal principle to observe in feeding a sick person is this: make the food look alluring. Much depends on the arrangement of the tray; spotless linen, sparkling silver and glass, and really nice china and cutlery have at least as much effect on the patient's appetite as has the food you offer him. Never give him large portions, they are disheartening even to look at. Give him small, carefully served portions, which will make him feel that you have been rather stingy with something exceptionally nice. A second helping can always be arranged; but a capricious appetite, once scared away, is not to be tempted back.

If the doctor has ordered slops for a time, use your ingenuity to make these amusing. Even bread-and-milk can be given a certain jauntiness if it contains a little brandy or rum (always supposing that this is sanctioned by the doctor). Or it can be flavoured with a drop or two of vanilla, or, for a child sufficiently ingenuous to approve of such false colours, it can be dyed pink with cochineal or yellow with saffron. You must be careful not to use so much of any flavouring agent that you upset the patient's digestion. Some patients will resent these cantrips, and prefer straight bread-and-milk; with these you must confine yourself to serving it in an attractive bowl.

Similar tricks can be played with junket; packets of junket powder are now on the market which confer a variety of flavours on this blameless dish. You can offer your patient chocolate, raspberry, lemon, orange, or vanilla junket, and the appearance of each is enticing. Numberless ideas for making dull food attractive will doubtless occur to you as soon as you begin to think about it. Rusks, for example, can be arranged in a pattern on a coloured dish. Beef-tea can be served with small and delicate croûtes of toast. Some people find egg-flips improved by a dash of port or whisky. Barley water can be flavoured with orange instead of lemon, and appear in your most agreeable glass jug with a little cracked ice clinking against the brim. Never leave a half-empty jug and a used glass beside the patient, or he will soon lose interest in his soft drinks. As the doctor is usually anxious for him to take as much fluid as possible, this is to be avoided.

CONVALESCENTS AND CHILDREN.

Little remains to be said about feeding convalescents, except that their diet needs to be steadily augmented as appetite returns. Feed them little and often with plenty of variety, and encourage their hunger by preparing surprise dishes for them. Probably the doctor will want them to have plenty of fresh food, and they will welcome unexpected

glasses of orange juice, fruit salad and cream at tea, and grape fruit for breakfast, in addition to an increasingly solid diet at other meals. Green salads can be made to look as attractive as a Victorian bouquet with a frill of crisp lettuce round the bowl, and the remaining ingredients skilfully arranged in the middle. Never let the onus of choosing his meals fall on the patient. If you know his favourite dishes surprise him with them. He may cry: 'Oh, I would like so-and-so to-day!'—in which case you can follow his lead and give it to him; but in the ordinary way you will have to do his thinking for him, and your success will depend on the imagination you bring to the task.

A child is often a difficult patient to feed. The doctor will generally want to get two things into him: fluids and sugar. If a child begins to turn with loathing from glucose-sweetened barley water, try him with the juice from a tin of peaches. Most children will drink this willingly; and the high sugar content makes them thirsty enough to drink plain water afterwards. Another way to tempt a child to eat is to offer him a meringue. Meringues consist of pure sugar and cream, and are really simple fare, in spite of their dashing reputation. Other children in the early stages of convalescence, when appetite is lacking, may respond to the offer of a cream ice. The practice of giving small meals frequently is especially important with children, because they can only lay in a small stock of energy at a time.

DIABETES AND PERNICIOUS ANAEMIA.

Diabetic patients are less of a responsibility to the housekeeper, in these days of insulin, than they used to be in the past. The task of standardizing the patient's diet at the outset is nearly always performed in hospital. The modern practice is to let the patient eat an ordinary diet, provided that he keeps within a certain daily limit for each of the three constituents: protein, carbohydrate, and fat. Usually the doctor or the hospital will provide the patient with a diet table which simplifies this task. Bread and potatoes need to be used sparingly or they may absorb most of his carbohydrate allowance for the day; the rest is a question of common sense and arithmetic.

Much more exacting is the lot of the home nurse who has to feed a pernicious anaemia patient on liver, liver, and yet more liver. Soon the sight of liver revolts patient and cook alike. Those faced with this problem will find an invaluable companion in *The Liver Diet Cookery Book*, by Dorothy Sewart, herself a patient with pernicious anaemia. Here you will read of liver soufflé, liver charlotte, toasted chicken liver, and many other promising dishes, and your difficulties will be solved.

Mechanical Devices

FOR PATIENTS CONFINED TO BED.

All sorts of devices are now available to make bed a pleasant place. For a patient who can sit up, a wooden back-rest is essential to support the pillows, as pillows alone invariably subside. A reading lamp is also necessary, and a convenient form is that which can be hung over the head of the bed by a strip of weighted cloth. The light is thrown over the patient's head on to the book he is reading, so that there is no glare in his eyes. If a bedside lamp is used, it should be placed well back on the table and so shaded as to achieve the same effect. The best type of bed-table is that which spans the bed completely and, running easily on castors, can be pulled up to the patient or pushed down to the foot of the bed as occasion requires. The type which stands on the bed with two short legs on either side of the patient is convenient when in position, but less easy to move. Tables which have a movable section forming a reading desk are seldom satisfactory; the desk usually tips up at the wrong moment, causing endless trouble. A separate reading desk, made like a music-stand set on an adjustable horizontal arm, is more useful, especially if it has a small shelf to hold a tumbler attached to the upright; a desk of this type is still useful when the patient becomes convalescent, and can sit out of doors. A bedside cupboard in which needlework, books, and other odds and ends can be stored when not in use, will help to keep the sick room tidy. Most patients who are well enough to use them will be delighted with a pair of lazy-tongs; these are made of aluminium, and will shoot out to a distance of a foot or two, enabling the patient to snap up objects otherwise out of reach.

FOR CONVALESCENT PATIENTS.

Many types of wheel-chair are made to-day; patients usually like designs which they can move and steer themselves. In summer, deck chairs and hammocks are pleasant places for convalescents, and a large coloured lawn-umbrella is welcome when the sun is too persistent. Long cane chairs can be made very comfortable with cushions, and a light fly-switch may prove a godsend. Another good resting place is to be found on a li-lo, one of the new rubber bags made rather like a water-bed but air-filled, which people take to the seaside with them nowadays; laid under a tree in the garden, this is an encouragement to idleness perfectly suited to convalescence. Later, when the patient essays his first walk, a shooting-stick is often a good companion.

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